ISSN 0549-3927

PALAEONTOLOGICAL SOCIETY OF JAPAN
SPECIAL PAPERS
NUMBER 30

A MONOGRAPH OF THE PUZOSIIDAE (AMMONOIDEA) FROM THE CRETACEOUS OF HOKKAIDO

By

Tatsuro MATSUMOTO

With Collaboration of Takemi Takahashi, Yoshitaro Kawashita, Kikuo Muramoto, Masatoshi Kera, Yasuji Kera, Toshio Shimanuki, Minoru Yamashita and Hakuji Kokubun in Part II

PUBLISHED BY THE SOCIETY
December 15, 1988

Special Papers, Palaeontological Society of Japan

*Number 1 (Issued September 25, 1951) Bibliography of Japanese Palaeontology and Related Sciences, 1941-1950 ..... Compiled by Riuji ENDÔ

*Number 2 (Issued March 1, 1954) Matajiro YOKOYAMA's Pliocene and Later Faunas from the Kwanto Region ..... Revised by Isao TAKI and Katsura ÔYAMA

*Number 3 (Issued August 31, 1957) Matajiro YOKOYAMA's Tertiary Fossils from Various Localities in Japan. Part 1 ..... Revised by Jirô MAKIYAMA

*Number 4 (Issued June 30, 1958) Matajiro YOKOYAMA's Tertiary Fossils from Various Localities in Japan. Part 2 ..... Revised by Jirô MAKIYAMA

*Number 5 (Issued December 15, 1959) Matajiro YOKOYAMA's Tertiary Fossils from Various Localities in Japan. Part 3 ..... Revised by Jirô MAKIYAMA

*Number 6 (Issued July 25, 1960) Matajiro YOKOYAMA's Tertiary Fossils from Various Localities in Japan. Part 4 ..... Revised by Jirô MAKIYAMA

*Number 7 (Issued November 30, 1961) Japanese Permian Bryozoa ..... Sumio SAKAGAMI

*Number 8 (Issued September 20, 1962) Tertiary Marine Mollusca from the Joban Coal-Field, Japan ..... Yasuhiko KAMADA

Number 9 (Issued December 15, 1962) Bibliography of Japanese Palaeontology and Related Sciences, 1951-1960 ..... Compiled by Fuyuji TAKAI

*Number 10 (Issued February 20, 1965) Late Tertiary Floras from Northeastern Hokkaido, Japan ..... Toshimasa TANAI and Nobuo SUZUKI

Number 11 (Issued February 20, 1966) The Echinoid Fauna from Japan and Adjacent Regions Part I ..... Syôzô NISIYAMA

Number 12 (Issued September 20, 1966) Postcranial Skeletons of Japanese Desmostylia ..... Tokio SHIKAMA

Number 13 (Issued March 16, 1968) The Echinoid Fauna from Japan and Adjacent Regions Part II ..... Syôzô NISIYAMA

*Number 14 (Issued November 25, 1969) Litho- and Bio-Facies of Carbonate Sedimentary Rocks —A Symposium— ..... Edited by Tatsuro MATSUMOTO

Number 15 (Issued February 25, 1971) Early Devonian Brachiopods from the Lesser Khingan District of Northeast China ..... Takashi HAMADA

Number 16 (Issued December 25, 1971) Tertiary Molluscan Fauna from the Yakataga District and Adjacent Areas of Southern Alaska ..... Saburo KANNO

Number 17 (Issued November 30, 1973) Revision of Matajiro YOKOYAMA's Type Mollusca from the Tertiary and Quaternary of the Kanto Area ..... Katsura ÔYAMA

Number 18 (Issued November 30, 1974) Silurian Trilobites of Japan in Comparison with Asian, Pacific and Other Faunas ..... Teiichi KOBAYASHI and Takashi HAMADA

Number 19 (Issued February 10, 1976) Bivalve Faunas of the Cretaceous Himenoura Group in Kyushu ..... Masayuki TASHIRO

Number 20 (Issued January 31, 1977) Devonian Trilobites of Japan, in Comparison with Asian, Pacific and Other Faunas ..... Teiichi KOBAYASHI and Takashi HAMADA

Number 21 (Issued May 10, 1977) Mid-Cretaceous Events—Hokkaido Symposium, 1976 ..... Organized by Tatsuro MATSUMOTO

Number 22 (Issued March 30, 1978) Bibliography of Palaeontology in Japan, 1961-1975 ..... Edited by Kametoshi KANMERA and Hiroshi UJIIE

Number 23 (Issued December 15, 1980) Carboniferous Trilobites of Japan, in Comparison with Asian, Pacific and Other Faunas ..... Teiichi KOBAYASHI and Takashi HAMADA

Number 24 (Issued December 15, 1981) Permian Conodont Biostratigraphy of Japan ..... Hisaharu IGO

(* Out of Stock)

Continued inside of back cover

Special Publications, Palaeontological Society of Japan

*Twenty-Fifth Anniversary Volume (Issued February 15, 1961) Catalogue of Type-Specimens of Fossils in Japan ..... Compiled by Shoshiro HANZAWA, Kiyoshi ASANO and Fuyuji TAKAI

*Twenty-Fifth Anniversary Volume (Issued September 16, 1963) A Survey of the Fossils from Japan Illustrated in Classical Monographs (Primarily a Nomenclatorial Revision) ..... Edited by Tatsuro MATSUMOTO

PALAEONTOLOGICAL SOCIETY OF JAPAN
SPECIAL PAPERS
NUMBER 30

A MONOGRAPH OF THE PUZOSIIDAE (AMMONOIDEA) FROM THE CRETACEOUS OF HOKKAIDO

By

Tatsuro MATSUMOTO

With Collaboration of Takemi Takahashi, Yoshitaro Kawashita,
Kikuo Muramoto, Masatoshi Kera, Yasuji Kera, Toshio Shimanuki,
Minoru Yamashita and Hakuji Kokubun in Part II

PUBLISHED BY THE SOCIETY
December 15, 1988

PALAEONTOLOGICAL SOCIETY OF JAPAN
SPECIAL PAPERS
NUMBER 30

This publication is printed by
the GRANT-IN-AID for PUBLICATION of SCIENTIFIC RESEARCH RESULT
of the MINISTRY of EDUCATION, SCIENCE and CULTURE

All Communications relating to this publication should be addressed to
THE SERIES EDITOR
c/o Department of Geology, Faculty of Science, Kyushu University, Fukuoka 812

Contents

Abstract

This is a revised and enlarged monograph of the ammonoid family Puzosiidae. The scheme of classification in Matsumoto (1954b) is not satisfactory especially in that the dimorphism was ignored at that date. Based on the specimens obtained carefully and patiently from the Cretaceous outcrops in Hokkaido as well as previous ones, examples of dimorphic pairs are now shown in a considerable number of species. The characteristic features in the adult stage and also in the immature stages should be investigated on both micro- and macroconchs. Through such ways of study the adequate scheme of classification would be led.

The family Puzosiidae in this paper is defined in a narrower sense than the subfamily Puzosiinae of the current use. The family consists of the genera (or taxa of generic rank) *Puzosia, Matsumotoceras, Mesopuzosia, Bhimaites, Pachydesmoceras, Anapuzosia, Jimboiceras, Austiniceras, Parapuzosia, Grandidiericeras, Lytodiscoides, Achilleoceras* and three other new genera with peculiar ornaments on the outer whorl of an adult stage. They all have huge or large macroconchs and finely and deeply incised suture of *Puzosia* pattern. In the last phase of the evolutionary history of the family, appear *Neopuzosia* and then *Kitchinites* (s. s.), which are small or medium sized but have evidence of dimorphism. All of these genera are defined or reviewed in Part I of this monograph. The puzosioid genera of Early Cretaceous ages with less complex sutures and without clear evidence of dimorphism are excluded from the Puzosiidae, whereas Hauericeratinae are to be referred to the Puzosiidae, as is discussed in another paper.

23 species of 10 genera from the Cretaceous (Albian to Campanian) strata of Hokkaido are amply described in Part II, and 2 others are discussed. For the descriptions of some species coauthorships are taken, depending on the responsibility. If we add *Grandidiericeras nagaoi* Matsumoto et Saito recently introduced elsewhere, then there are 26 species of 11 genera in Hokkaido, of which 6 new species are established in this paper. In connexion with the descriptions, some species already errected on the specimens outside the Japanese province are reviewed.

A MONOGRAPH OF THE PUZOSIIDAE (AMMONOIDEA) FROM THE CRETACEOUS OF HOKKAIDO

By

Tatsuro MATSUMOTO

(Studies of Cretaceous Ammonites from Hokkaido — LXIII)

Preface

More than 30 years have passed since I monographed the ammonites of the Puzosiidae from Hokkaido and South Sakhalin (Matsumoto, 1954b). In addition to the material of that study, more ammonites of this group have been acquired in Hokkaido by several friends of mine as well as myself, but only a few of them have been reported (Matsumoto *et al.*, 1972; Matsumoto, 1987; Matsumoto and Saito, 1987).

In the descriptions of ammonites of this group from the extra-Japanese provinces, some authors followed the scheme of classification in my 1954b paper, some others revised a part of that scheme, and still others complained of inadequate or doubtful points. There are indeed difficulties in the study of the Puzosiidae (or Puzosiinae by some authors), as will be fully remarked in the text below, but I introduce a leading principal to improve my previous work. It would be better to present the result obtained up to this time, leaving further problems to be worked out in the future.

In this study a number of competent field workers or naturalists have cooperated with me. In some cases they have generously provided their valuable collections for this study and in some other cases I have invited some of them to do a joint work in the description of the species concerned. Under these circumstances, two parts are set in this monograph.

Part I is chiefly concerned with the major classification, with introductory remarks at the beginning. The taxonomy at generic rank occupies the major part. I am solely responsible for Part I.

Part II contains the descriptions of species. Coauthorship is taken for some species in accordance with the responsibility in the study.

Acknowledgements

I sincerely thanks the cooperation and help in this work by a number of persons, whose names are recorded in the introductory remarks below. Especially I would like to appreciate the keen sight of certain persons to find out scientifically valuable, well preserved specimens and the laborious field works by several competent persons who hunted for and brought huge specimens into scientific investigation.

I thank the curators and staff of museums and institutions who have allowed me to study specimens in their care and helped me in various ways: Professors T. Shuto, J. Yanagida and

K. Kanmera (GK.); Drs. N. Kanbe, T. Sakamoto and T. Onoe (GSJ.); Professor M. Kato and Dr. N. Minoura (GMH.); Professor T. Kotaka, Dr. K. Ogasawara and Mr. S. Otomo (IGPS.); Messrs. K. Muramoto and T. Shimomura (MCM.); Dr. I. Obata (NSM.); Professor I. Hayami, Dr. M. Utada, Messrs. K. Ichikawa and T. Okamoto (UMUT.), Mr. M. Kikuchi (Mikasa High School); Dr. M. K. Howarth and Mr. D. Phillips (BMNH.); Mr. M. V. S. Sastry (GSI.); Dr. Jacques Sornay (MNH.) and Dr. C. W. Wright (WW.).

This work has been carried out mainly for these several years, i.e. well after my retirement from Kyushu University and thanks are due to Professor K. Kanmera who has given me every possible fascility to study there; thanks are also extended to Professor Y. Karakida of Seinan-gakuin University where I performed a part of this work as an honorary member (from April 1981 to March 1986).

Aside from the financial support from the Seinan-gakuin in accordance with the standing rules, this work has not be particularly financed by any organization, but the activity of the regional working group in Japan in cooperation with the IGCP Project No. 58 of "Mid-Cretaceous Events" (MCE) has stimulated me much to carry on this investigation, since the basic material came mostly from the strata ranging from Albian to Coniacian. In other words, this work can be regarded as a byproduct of the MCE. In this sense I owe much to Professor R. A. Reyment and Dr. P. Bengtson of Uppsala, the leader and secretary of the MCE, and I have been much encouraged by the active members of the MCE, who have been engaged in ammonite palaeontology and biostratigraphy, especially the late Professor Tove Birkelund, Dr. C. W. Wright, Dr. J. M. Hancock, Dr. W. J. Kennedy, Dr. Jost Wiedmann, Dr. W. A. Cobban and Professor K. Young, although my own view may be different from theirs in some parts.

Some of the necessary references are inaccessible in Fukuoka and Dr. I. Obata of National Science Museum, Professor M. Kato of Hokkaido University and Professor K. Chinzei and Dr. T. Ohno of the University of Kyoto have kindly helped me in this respect.

The photographs of the specimens were taken mostly by courtesy of Dr. Masayuki Noda and partly by Mr. S. Otomo, Dr. Tomoki Kase and Mr. Shinichi Sato, whom I thank with all my heart together with coauthors for their kindness. Thanks are extended to Dr. S. Toshimitsu who helped me in many ways in Kyushu University, and to Miss Yoshimi Tanigawa 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 Editor, and the anonymous referees in setting forth the improved manuscript into *Special Papers* No. 30 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.

April 30, 1987

Tatsuro Matsumoto
c/o Department of Geology,
Kyushu University, Fukuoka

PART I
MAJOR CLASSIFICATION

By

Tatsuro MATSUMOTO

Introduction

Material:—The basic material for this study consists mainly of the specimens collected from the Cretaceous strata exposed in various areas of Hokkaido. They are kept partly in the following institutions with abbreviations in parentheses:

Geological Collections, Kyushu University, Fukuoka (GK.)
Geological Museum, Geological Survey of Japan, Tsukuba (GSJ)
Institute of Geology and Mineralogy, Hokkaido University, Sapporo (GMH.)
Institute of Geology and Palaeontology, Tohoku University, Sendai (IGPS.)
Mikasa City Museum, Mikasa, Hokkaido (MCM.)
National Science Museum, Tokyo (NSM.)
University Museum, University of Tokyo (UMUT.)
Yokosuka City Museum, Yokosuka (YCM.)

Wealth of material owes partly to the collections of Messrs.

Yoshitaro Kawashita (YKC.) in Tomatsu, Mikasa,
The Muramotos (MC.) in Yayoi, Mikasa, and
Takemi Takahashi (TTC.) in Yayoi, Mikasa,

who not only supplied their valuable and often large specimens for this study but also helped me in the field works. Some more specimens, which are mostly large or huge, obtained by Ms. Kikuye Kato and Messrs. Koji Hasegawa, Tadashi Hashimoto, Masatoshi Kera, Yasuji Kera, Hiroji Kokubun, Kanichi Morita, Toshio Shimanuki, Hisao Shimogawara, Akio Tomita and Minoru Yamashita have been also examined.

I owe much to Drs. Akitoshi Inoma, Suteichi Nagao, Yoshiro Ueda, Tetsuro Suekane and Seiichi Toshimitsu, who kindly showed me and presented the valuable specimens, which they obtained through their laborious field works, to Kyushu University. Many of the specimens kept at UMUT and GK were obtained by my own field works aided from time to time by Drs. Hakuyu Okada, Masato Harada, Hiromichi Hirano, Kazushige Tanabe, Tamio Nishida, Masafumi Arita and Masayuki Noda as well as Messrs. T. Takahashi, Y. Kawashita and T. & K. Muramoto.

Locality records and stratigraphy:—The investigated specimens came from various areas of Hokkaido (Fig. 85), among which the Abeshinai-Saku, Haboro-Kotanbetsu and Obira areas in the Teshio Mountains (north western Hokkaido), Ashibetsu, Ikushumbets (or Mikasa), Yubari, Oyubari, and Hobetsu areas in the Yubari Mountains (central Hokkaido) and the Urakawa area on the coast of south-central Hokkaido are the major part for this study. Some of the specimens studied previously (Matsumoto, 1954b; Matsumoto *et al.*, 1972) have been reexamined, which include those from the Naibuchi and Aikawa areas in South Sakhalin.

For the lcoations in detail (plotted on route maps) as well as the local stratigraphy, the readers may refer to Matsumoto (1942-43), Ueda *et al.* (1962), Tanaka (1963), Matsumoto and Harada (1964), Matsumoto (1965), Hirano *et al.* (1977), Tanabe *et al.* (1977), Matsumoto and Haraguchi (1978), Toshimitsu (1985), Matsumoto and Toshimitsu (1985) etc. Also official geological maps are available for these areas, *viz.* Hashimoto *et al.* (1965), Igi *et al.* (1958), Matsuno *et al.* (1964), Nagao *et al.* (1954), Shimizu *et al.* (1953), Tsushima *et al.* (1958), *etc.* For a few localities which were unrecorded in any published report, three maps (Figs. 86-88) are shown in this paper. As to the local stratigraphy revision may be necessary for some parts. For the up-to-date and over all stratigraphy an article in the "Mid-Cretaceous Events" Symposia at Uppsala-Nice (Matsumoto *et al.*, 1978) may be useful, but even this is becoming out-of-date in certain parts, e.g. for the Upper Turonian and Coniacian, which should be supplemented by Matsumoto (1984a) and Toshimitsu (1985).

In comparison with the specimens from Hokkaido, I examined some specimens kept at the followig institutions by courtesy of the authorities there:

British Museum (Natural History), London (BMNH. or BM.)

Geological Survey of India, Calcutta (GSI.)

Museum d'Histoire Naturelle, Pais (MHN.)

C. W. and E. V. Wright Collection, formerly London (WW.)

Terminology:—The morphological terms defined or written in the *Treatise* (Arkell *et al.*, 1957) are in general used in this paper, but for inner and outer parts of the flank (of a whorl) instead of lower and upper.

The adjective terms are often used in the description in accordance with the definition by Matsumoto (1954a, p. 246). As that book is now out of stock, they are cited below with slight modification.

Size of shell

very small = diameter less than 35 mm
fairly small = diameter from 35 mm to nearly 75 mm
moderate = diameter from 75 mm to nearly 125 mm
fairly large = diameter from 125 mm to 250 mm
very large = diameter more than 250 mm but lese than 500 mm
huge or gigantic = more than 500 mm

Width of umbilicus (in proportion to the entire shell diameter)

very narrow = less than 8%
narrow = 8% to nearly 17%
fairly narrow = from 17% to nearly 30%
moderate = from 30% to nearly 40%
fairly wide = from 40% to nearly 50%
wide = from 50% to 65%
very wide = more than 65%

Compression of whorl

defined by the proportion of whorl-breadth to whorl-height (B/H)

compressed or higher than broad { much compressed = $B/H < 2/3$; fairly compressed = $1 > B/H > 2/3$

as high as broad = B/H = 1

depressed or broader than high { fairly depressed = 3/2 > B/H > 1
much depressed = B/H > 3/2

Involution of whorl

overlapped part of the next inner whorl, measured in whorl-height

evolute ..... { very evolute = less than one third
fairly evolute = about one third

moderate ..... about a half

involute ..... { fairly involute = nearly two thirds
very involute = more than two thirds

Dimensions:—These are shown in a similar way to those in Wright and Kennedy (1984), with some modification in the abbreviation:

D = diameter of shell, U = width of umbilicus,
H = whorl-height, B = whorl-breadth

Measurements are in millimeters and figures in parentheses are proportion to the diameter (l).

In addition to the above, the following letters and signs may be used:

h = whorl-height at 180° adapically from H
R = radius, r = radius at 180° adaptically from R
H/R or R/r indicates the rate of whorl-expansion in 180°
Inv = involution of whorl (degree of overlapping)
LS = last suture (at the LS, i.e. end of phragmocone)
LS + 90° = at a point 90° adorally from LS
LS − 120° = at a point 120° adaptically from LS
E = preserved end, E − 120° = at a point 120° adaptically from E.
c = costal, ic = intercostal (measured on strongly ribbed form)
(fig.) = measured on illustrations
c. = approximate or inferred

Illustrations:—The figures with photos and drawing in this monograph are in most cases the right and/or left lateral, frontal and ventral (back) views, as in many other papers. These routine views are so obvious that they are not explained repeatedly. Only when the figure is from a particular angle, it will be explained. An arrow mark means the position of the last suture (LS) and Q that of the whorl-section. The photographs were mostly taken by Dr. M. Noda, whose name is not indicated repeatedly in the captions of figures for brevity.

Classification at Family Level

In the *Treatise* (Arkell *et al.*, 1957) and more recently published *The Ammonoidea* (Wright *in* House and Senior (eds.), 1981, p. 169), the Puzosiinae Spath, 1922 is one of the subfamilies of the family Desmoceratidae. In the scheme of Wright (1955; 1957 *in* Arkell *et al.*)

Eodesmoceratinae was included in the Desmoceratidae and regarded as a fundamental stock of the family together with the Puzosiinae in the sense of Wright. Recently Wright (1981) has set Eodesmoceratidae at an independent family, probably taking Beskovski's (1977) work into consideration.

Matsumoto (1954b) has defined the Puzosiinae (Puzosiidae in that paper) in a narrower sense than the Puzosiinae of Wright (1955), excluding the genera with puzosioid aspects of Aptian and older ages, such as *Valdedorsella* Breistroffer, 1947, *Pseudohaploceras* Hyatt, 1900, *Callizoniceras* Spath, 1923, *Silesitoides* Spath, 1925, *Feruglioceras* Leanza, 1967, (accordingly *Umsinenoceras* Kennedy, Wright et Klinger, 1979) and even *Melchiorites* Spath, 1923.

The genera of the Puzosiinae in my sense have typically less involute, more or less compressed whorls, which have normally more or less flexuous, outward projected, periodic constrictions, collared or flared on the shell, and riblets or ribs on the interspaces, but in a few genera whorls may be more involute and in some other genera less compressed or more inflated and may have stronger ornamentation especially in the late growth-stage.

Members of the Puzosiinae developed in fairly diverse ways in shell-form and ornamentation, but show commonly a characteristic pattern of suture, which has a large, asymmetrically tripartite lateral lobe (L) and a strongly retracted suspensive lobe and is finely and deeply incised in the middle to late growth-stages.

The sutural formula based on the ontogenetic development is stated to be kept constant throughout the Desmoceratacеae (Schindewolf, 1966; Kulmann and Wiedmann, 1970), having double U1. The formula of the Puzosiinae in my observation was E L U2 U3 = S U1, I, but interpreted by Schindewolf as E L U2 U3 U4 = S U1v U1d I. Mikailova (1983) recognizes double U1 but her formulae are dissimilar from the German scholars'.

Apart from the sutural formula, the sutural pattern in the middle to late growth-stages is particular to the Puzosiinae and well distinguished from that of the Eodesmoceratinae or that of the Desmoceratinae. The Puzosiinae (or Puzosiidae) in my strict sense is thus defined by the possession of the particular sutural pattern in the middle to late growth-stages. The illustration by Kossmat (1898, pl. 23, fig. 4) represents that particular pattern. I excluded the above enumerated genera of puzosioid aspects, because their sutural patterns are not of *Puzosia* type in the less asymmetric and less expanded L and non- or less retracted auxiliaries as well as the less intricate divisions. Obata (1967), for instance, is in favour of my view, excluding *Valdedorsella* from the Puzosiinae. *Melchiorites* may be critical in this respect for it shows some features which can be regarded as transitional to *Puzosia* or *Bhimaites*.

The presence of marked dimorphs can be reckoned another diagnostic feature of the Puzosiinae in my sense, whereas no example of significant dimorphism has been reported in the above enumerated puzosioid genera and also in the Desmoceratinae. In many genera of the Puzosiinae, macroconchs are very large or huge, and often have peculiar ornament, whereas microconchs are much smaller. The existence of such dimorphs is anatomically very significant. Therefore I think it better to rank up this group to a family.

As I report, together with Toshimitsu, on another occasion (oral comm., 1987), there are similarly distinct dimorphs in the genus *Hauericeras* de Grossouvre, 1894, which is also morphologically allied to some *Puzosia*.

Accordingly the subfamily Hauericeratinae Matsumoto, 1938 should be affiliated to the Puzosiidae. In other words the Puzosiidae in my revised definition consist of the subfamilies

Puzosiinae (in my sense) and Hauericeratinae.

Genera and species of the Puzosiinae are described and discussed in this monograph.

A Guiding Principle of Classification

The family Puzosiidae in my sense include numerous examples of large or huge forms. In the ammonites of the Cretaceous of South India described over 120 years ago by Stoliczka (1865), there are at least two huge puzosiid ammonites, *Ammonites planulatus* in Stoliczka's sense (referred to *Puzosia* in the current taxonomy) and *Ammonites denisonianus* Stoliczka, the type species of *Pachydesmoceras.*

Pachydiscus seppenradensis Landois, 1895, a famous huge ammonite from the Upper Cretaceous of Germany, is currently regarded as *Parapuzosia,* though with a query (see Summesberger, 1979), whereas *Parapuzosia bradyi* Miller et Youngquist, 1946 is one of the huge ammonites from the Upper Cretaceous of North America.

In addition to these well known examples, persons working in the Cretaceous areas often meet with large or huge puzosiid ammonites, whereas there are more numerous ones of smaller or moderate size. How to connect taxonomically the smaller forms with the large or huge ones is one of the difficulties in the study of this group.

Meanwhile, Matsumoto and Inoma (*in* Matsumoto *et al.* 1972) noticed some well preserved specimens of small to medium size whose peristome is lappeted. Since then I have had an idea that large or huge forms of this group may probably represent macroconchs. My previous scheme of classification of the Puzosiidae (Matsumoto, 1954b) was fundamentally insufficient because of the ignorance of dimorphic pairs. One should carefully recognize the microconch which would form a dimorphic pair with the macroconch or *vice versa.*

Recently the idea of dimorphism has been in general considered by palaeontologists working in the Jurassic and Cretaceous ammonites. As to the puzosiids, however, satisfactory work is few. For instance, some author has proposed to define a genus (or subgenus) on the characters of phragmocone alone, because the adult body-chamber shows much difference in a dimorphic pair. I should take into consideration the characters of both the micro- and macroconchs at every growth-stage. This is by no means easy, but if one patiently and earnestly looked for the good material on this guiding principle, the true affairs would eventually come out. In this study several friends of mine helped me along this line with their keen sight and through laborious works.

As a result, dimorphic pairs have been made clear evidently in a considerable number of species and genera. In some cases, however, the existence of the dimorphs has been recognized but not yet sufficiently confirmed by the specimens which preserve the peristome.

In the Puzosiidae there are several taxa in which the body-chamber of a large form has extraordinary ornament. *Lytodiscoides* Spath, 1922, *Achilleoceras* van Hoepen, 1951 and *Anapuzosia* Matsumoto, 1954 are such examples among the hitherto proposed genera. In the Cretaceous of Hokkaido there are still more examples. They were conventionally or temporarily called *Anapuzosia,* but when they are studied carefully they differ from true *Anapuzosia* in some important points and I am going to introduce three new taxa of generic rank. They are all large or huge and probably macroconchs. It is, however, regrettable that no corresponding microconch has been confirmed for any of the above genera (or subgenera), except for *Anapuzosia.* This should be worked out in the future.

The relationships between species or genera should be investigated by comparison of the characters at every growth stage.

Genera of the Puzosiidae

In this chapter I give a result of my restudy on the classification at generic level. Some authors may use subgenera for some species group. This seems to have come sometimes from the similarity of characters in immature shells or occasionally from the resemblance of particular characters in the adult body-chamber. When I investigate the characters of the phragmocone and body-chamber (or generally at every growth stage) on both the macroconch and microconch, the relationship of the taxa at generic level is not so simply understood as to allow me to regard a given species group as a subgenus of a certain genus. I am rather inclined to recognize generally the evolutionary development in diverse trends. Therefore, I treat in this paper every taxon of generic level as a genus, avoiding a subdivision into subgenera.

The order of arrangement in the descriptions of the genera in this chapter does not necessarily imply the successive affinity of the genera. Although I take into consideration a similarity in some characters between them, they may be different in some other points.

Genus *Puzosia* Bayle, 1878

Type species:—*Ammonites planulatus* Sowerby, 1827 (non Schlotheim, 1820) = *Ammonites mayorianus* d'Orbigny, 1841. See Wright and Kennedy (1984, p. 54).

Diagnosis:—Microconch medium sized; macroconch very large or huge. Whorls fairly evolute or of moderate involution, more or less higher than broad, compressed and flat sided or suboval with gently convex flanks, narrowly or moderately rounded venter, subangular or abruptly subrounded umbilical shoulder to low but vertical umbilical wall and shallow umbilicus of moderate width.

Constrictions more or less sinuous in most cases, sometimes falcoid and occasionally simply concave on the main part of flank and more or less projected on the outer part. Fine lirae, then riblets or subcostae and then numerous fine ribs, mostly on the outer part of the whorl, fading away on the inner flank, but for a few which may extend inward but much reduced to lirae. Ribs nearly parallel to the outer part of the constrictions.

Microconch provided with ventral rostrum and long lateral lappets at the peristome. Trace of the apertural margin may remain as strongly sigmoid or falcoid line at certain place adapically from the last peristome.

In the late growth-stage of large macroconch the ribs and periodic flares (or constrictions) weaken, resulting in nearly smooth main part of the body-chamber, on which blunt, major redial undulations may be disposed at wide intervals around the umbilicus.

Suture of typical *Puzosia* pattern as mentioned in the remarks on the family.

Discussion:—The genus *Puzosia* in this paper is equal to the subgenus *Puzosia* (*Puzosia*) recently redefined by Wright and Kennedy (1984, p. 54-55).

Anapuzosia Matsumoto, 1954, which has been referred to *Puzosia* as a subgenus, is in my present opinion an independent genus and may be related to *Pachydesmoceras* Spath, 1922.

Mesopuzosia Matsumoto, 1954 may be a direct descendant of *Puzosia,* with longer ribs becoming more predominant. It coexisted with *Puzosia* in the Turonian and persisted up to the late Campanian. It is a branch from *Puzosia* and I treat it as an independent genus. *Bhimaites* Matsumoto, 1954 is to be reviewed later.

Occurrence:—Lower Albian to Turonian, almost world-wide; also Coniacian of Madagascar, South Africa (?) and Japan, although less common.

Genus *Matsumotoceras* van Hoepen, 1968

Type species:—*Matsumotoceras donlisteri* van Hoepen, 1968, from the Coniacian of South Africa (original designation).

Remarks:—As I have not examined the holotype of the type species, I have to follow van Hoepen (1968, p. 157, pl. 1; text-fig. 1a) for the definition of this genus. The generic diagnosis may be concisely rewritten as follows: Similar to *Puzosia* in shell-form and also in having numerous, fine riblets on the outer part of whorl. Main part of the huge last whorl nearly smooth, without constrictions and only with broad radial undulations on the inner two thirds of the flank.

Hoepen wrote that "There are no constrictions", but I interpret that this is only applied to the preserved last whorl, which consists of a part of the body-chamber and the last part of the phragmocone. The photograph seems to show, though indistinctly, several constrictions on the inner whorls.

If the above observation is correct, it follows that *Matsumotoceras* was named for a macroconch of *Puzosia*. Although *Puzosia* in a strict sense is not common in the Coniacian, Collignon (1961, pl. 5, figs. 1, 2) illustrated two species from Madagascar, of which *P. manasoaensis* Collignon (1961, p. 34, pl. 5, figs. 2, 2a, 2b) has numerous, dense and fine riblets and very weak constrictions. Its type is medium sized (D = 108 mm at E) and has compressed, rather flat sided whorls. This may be either the phragmocone of a microconch or a nuclear part of a very large macroconch. In general the outer whorl of an adult macroconch in *Puzosia* or *Mesopuzosia* is less compressed with more convex flanks than the inner whorls. Therefore, there is a possibility that *Matsumotoceras donlisteri* van Hoepen, 1968 could be an adult macroconch of *Puzosia manasoaensis* Collignon, 1961. This idea should be examined on sufficient material.

Incidentally a specimen from the Coniacian of Hokkaido, to be described under *Puzosia* cf. *manasoaensis* in Part II (p. 43) of this monograph, is much larger than the holotype from Madagascar, with D = 320 mm at LS near the preserved end.

In short, I suggest that *Matsumotoceras* could possibly be a synonymous name given for a macroconch of *Puzosia*. Until this is confirmed on sufficient evidence, *Matsumotoceras* should be kept in mind.

Genus *Mesopuzosia* Matsumoto, 1954

Type species:—*Mesopuzosia pacifica* Matsumoto, 1954 (original designation, Matsumoto, 1954b, p. 79).

Diagnosis:—Similar to *Puzosia* in shell-form and suture, but distinct in having well developed costae. From fairly early in the middle growth-stage onward, many ribs are long, arising at or near the umbilical rim, with shorter ones intercalated on the flank, more or less sigmoidal, or

gently arcuate (concave); all the ribs rather narrow and of nearly equal intensity, crossing the venter with projection. Periodic constrictions and associated flares persist to the late growth-stage.

Microconch of medium size in the adult, with much elongate lateral lappets and moderately projected ventral rostrum at the periostome. Ribs and flares (or constrictions) persist to the last part of the body-chamber, in which the last flare demarcates the posterior border of the marginal part.

Macroconch large or huge, with gradual weakening ribs and flares or shallowed constrictions in the late growth-stage. Adult body-chamber may be fairly inflated and smoothed, but for blunt radial elevations or undulations on the flank, showing an aspect distinct from microconch.

Discussion:—The diagnosis given in the original definition (Matsumoto, 1954b, p. 79) is essentially kept. Speaking generally, *Mesopuzosia* was probably derived from *Puzosia,* acquiring better developed ribbing, but it is by no means easy to trace a line of descent from a species to another.

Mesopuzosia resembles *Parapuzosia* Spath, 1922, but the latter has frequent major (stronger) ribs which diverge outward to minor ribs as narrow as the intercalated ones.

The dimorphic pair as diagnosed above are typically recognized in *M. pacifica* and *M. yubarensis* (Jimbo), which are redescribed below.

Even if the dimorphic pair has not yet been well ascertained, some more species are referable to *Mesopuzosia.* Examples are a new species established below, from the Turonian of Hokkaido, and *M. densicostata* Matsumoto 1954, from the Santonian and Campanian of Hokkaido and Sakhalin (see Matsumoto, 1954b, p. 87, pl. 22, figs. 1, 2; Matsumoto, 1984b, p. 13, pl. 2, figs. 1, 2).

As I have discussed already in comparison with *Puzosia orientalis* Matsumoto, 1954, *P. gaudemarisi* Roman et Mazeran, 1913, from the Turonian of France is probably an example of *Mesopuzosia* in Europe and this species is regarded by Wright (1979) as a synonym of *P. curvatisulcata* Chatwin et Withers, 1909, from the British Chalk Rock.

Puzosia indopacifica Kossmat, from the Coniacian of India, is flat-sided and rather atypical but conventionally referred to *Mesopuzosia,* as I shall disuss later. What was called *Parapuzosia indopacifica* (Kossmat) by Collignon (1932) is a good example of *Parapuzosia* and not the named species. It has an outer whorl (still septate) which is close to *Parapuzosia haughtoni* Spath, 1922, from South Africa, in the oval section with somewhat convex flanks and the ornamentation characterized by frequent major ribs diverging outward to minor ribs. I examined the former in Paris (MHN.) and the latter in London (BM.). Likewise, *Mesopuzosia bererensis* Collignon (1961, p. 52, pl. 21, fig. 1), from the Campanian of Madagascar, is a *Parapuzosia* or an *Austiniceras.*

The specimens described under *M. pacifica* by Collignon (1961, p. 50, pl. 15, fig. 2; pl. 20), from the "Lower Turonian" Zone of *Fagesia superstes* of Madagascar may be within the variation of that species but the larger one (*op. cit.,* pl. 20) is somewhat allied to *P. orientalis* redescribed in Part II of this paper, suggesting an intimate relationships between *Puzosia* and *Mesopuzosia.*

M. ambikiyensis Collignon (1961, p. 51, pl. 13, fig. 2), from the Upper Turonian and Lower Coniacian of Madagascar, is an atypical *Mesopuzosia* in its flat and parallel flanks and oblique constrictions, foreshadowing *Neopuzosia* or *Kitchinites. Neopuzosia matsumotoi* Collignon (1961, p. 54, pl. 23, fig. 1), from the Upper Turonian and Lower Coniacian of Madagascar, is noteworthy in showing some characters of *Mesopuzosia.* Collignon himself hesitated to refer it to *Neopuzosia* and Howarth (1965, p. 387) preferred *Mesopuzosia,* although in my opinion, it differs from *M.*

pacifica in its flatter flanks and less sigmoidal ribs. As the ribs on the last half whorl are coarsened than those of the preceding stage, it could be assigned to *Neopuzosia,* but on the body-chamber of typical species of *Neopuzosia* the ribs are more distinctly coarser and stronger on the outer part (i.e. outer flank and venter). In *Kitchinites* the constrictions run obliquely forward cutting some ribs behind them. This character is discernible only in an immature stage of *N. japonica* Spath and *N. ishikawai* (Jimbo) (see Matsumoto, 1954b), but it does not appear in *N. matsumotoi.* It may be better to transfer this species to *Mesopuzosia,* but the fact that *M. matsumotoi* foreshadows some characters of *Neopuzosia* is interesting.

Incidentally, *Puzosia eboroensis* Collignon (1961, p. 34, text-fig. 1), from the Coniacian Zone of *Barroisiceras onilahyense* of Madagascar, is a good example of *Mesopuzosia.* The primary ribs in Collignon's description are the flares associated with constrictions and many of his "secondary ribs" are long, arising at or near the umbilical rim.

Mesopuzosia occurs commonly in Sakhalin and Kamchatka (e.g. Matsumoto, 1954b; Verechagin *et al.*, 1965). I would expect more examples of this genus from Alaska and California than those described previously (e.g. Jones, 1967; Matsumoto, 1959a). There is a record of solitary occurrence in the Turonian of Venezuela (Renz, 1982). A species described under *Mesopuzosia* from Angola (Howarth, 1965) is better transferred to *Pachydesmoceras* (see p. 76 of this paper).

Occurrence:—To sum up the above remarks, the genus *Mesopuzosia* ranges stratigraphically from the Lower Turonian to Upper Campanian and flourished in the Turonian and Coniacian. Geographically it occurs abundantly or fairly commonly in the regions facing the North Pacific and Indian Oceans. In the shelf seas of Europe and North America (excluding the Pacific side), it is rare and seems to be replaced by *Parapuzosia.* The two genera occur in Madagascar, but in strata of different ages. For some reasons *Mesopuzosia* distributed in more restricted areas than world-wide *Puzosia*, from which it must have been derived.

Genus *Neopuzosia* Matsumoto, 1954

Type species:—*Kitchinites japonicus* Spath, 1922 (original designation by Matsumoto, 1954b, p. 89).

Diagnosis:—Microconch small; macroconch medium-sized. Similar to typical *Puzosia* in shell-form and suture, having rather evolute or moderately involute and compressed whorls, which are higher than broad, with rather narrowly arched venter, gently convex flanks and subrounded umbilical shoulder, encircling shallow and moderately wide umbilicus. In the phragmocone constrictions and/or associated collars prorsiradiate on the main part of flank, with or without slightly sigmoidal flexuosity, and markedly projected on the ventral part. Phragmocone ornamented at first with fine lirae, then subcostae and still later narrow ribs of unequal length, many of which are long, arising at or near the umbilical rim, with inserted or occasionally branched shorter ones, more or less sigmoidal on the main flank, gradually curved to the moderate projection on the ventral part. A few shorter ribs compensate the space behind the more projected constriction.

Body-chamber of macroconch ornamented with thick, strong and rather rectiradiate (i.e. less or non-sigmoidal) major ribs and occasionally associated short but equally thick and strong ribs. They may be curved somewhat forward on the ventral part. The constrictions on the body-chamber nearly parallel to the long ribs. The apertural margin in front of the last flare nearly smooth, only with lirae and faint riblets. Peristome rostrate on the venter but gently flexuous on the side, forming moderate ventrolateral and shallow umbilical sinuses.

Body-chamber of microconch ornamented with the same type of ribs and periodic, collared constrictions as those of the phragmocone, with gradually increased distinctness and decreased density, without abrupt development of strong and straight major ribs. Some ribs still persist to be more or less flexuous. The ribs are weaken and replaced by subcostae or fine lirae on the interspace between the approximated last two constrictions. The peristome provided with fairly long rostrum and much projected lateral lappets, forming very deep ventrolateral and narrow umbilical (i.e. probably ocular) sinuses.

Discussions:—I refer the following three species to *Neopuzosia* without hesitation:

(1) *N. japonica* (Spath, 1922): Upper Coniacian to Lower Campanian; Japan and Sakhalin
(2) *N. ishikawai* (Jimbo, 1894): Santonian and Lower Campanian; Japan and Pacific region of the USSR
(3) *N. haboroensis* Matsumoto et Inoma, 1972: Santonian and Lower Campanian; Japan

In addition, *Kitchinites* (s. l.) *stenomphalus* Summersberger, 1979, from the Santonian of Austria, may be a *Neopuzosia,* but is still doubtful because of the absence of the body-chamber.

As to *N. matsumotoi* Collignon, 1961, from the Upper Turonian and Coniacian of Madagasar, I agree with Howarth (1965, p. 387) in revising it to *Mesopuzosia,* but I am in favour of Collignon (1961, p. 54) in giving notice of some transitional features in this species between *Mesopuzosia* and *Neopuzosia.*

There is another interesting form from the Turonian of Hokkaido, which is represented by a specimen (no. A3) in T. Suekane's Coll., now kept at Yokosuka City Museum, YCM. 712 (Fig. 33 F—H of this paper). It is called provisionally *Mesopuzosia* aff. *intermedia* (Kossmat) but shows some characters which could be regarded as ancestral to *Neopuzosia japonica.* For more details see the description of *N. japonica* in Part II (p. 88).

Although *Neopuzosia* is allied to and probably derived from some species (or subgroup) of *Mesopuzosia,* it is distinguished in its young shell by the outward much projected constrictions which are oblique to the main ribs behind them and also in its adult macroconch by the less or non-sigmoid strong ribs on the body-chamber, where constrictions persist. The adult macroconch of *Mesopuzosia* is generally much larger and numerous ribs and periodic flares (or constrictions) weaken and then disappear on the outer whorl, where more or less blunt, major radial undulations are disposed at wide intervals on the otherwise smooth surface. In *Mesopuzosia* microconchs are much smaller than macroconchs but still larger than or as large as macroconchs of *Neopuzosia.* In *Neopuzosia* the difference in size between the macro- and microconchs is not so great as in *Mesopuzosia.*

As to *N. japonica,* there are now examples of adult macroconch and microconch both. The macroconch, with the peristome preserved, is about 120 mm in diameter, whereas the microconch is estimated as 65 to 70 mm, about or slightly larger than a half of the macroconch in diameter, although a complete specimen with the peristome preserved has yet to be searched for. In response to my inquiries, S. Toshimitsu kindly showed me similar examples of both macro- and microconchs of *N. ishikawai* in his collections from the Haboro area.

Since *N. haboroensis* was established by Matsumoto and Inoma (*in* Matsumoto, Muramoto and Inoma, 1972), no further material of this species has been added. It is represented only by microconchs, which are much smaller than those of *N. japonica* or *N. ishikawai,* only 30 mm or so in the maximum diameter. Therefore, it is an independent species and an interesting example of paedomorphic dwarf. Anyhow the macroconch which makes a pair with this microconch should

be searched for.

To sum up, *Neopuzosia* is well defined on the basis of intensively studied specimens. *Kitchinites* should be investigated more carefully before one claims *Neopuzosia* as its synonym. The distinction between them on my present observation will be given below in the remarks on *Kitchinites*.

Occurrence:—*Neopuzosia* occurs very commonly in the Santonian and lower part of the Campanian in Japan; also in the Pacific region of the USSR. There is a record of its occurrence in the Upper Coniacian of Hokkaido (see the description of *N. japonica*).

Possibly *Kitchinites* (s. l.) *stenomphalus* Summesberger, 1979 could be an example of *Neopuzosia* from the Santonian of Europe, whereas *K.* (*N.*) *guanaquensis* Nello *et al.*, 1980 was reported from Argentina.

Genus *Kitchinites* Spath, 1922

Type species:—*Holcodiscus pondicherryanus* Kossmat, 1897, from the Valudayur Beds of South India (original designation by Spath, 1922, p. 127).

Diagnosis:—Macroconchs mostly medium-sized but may be fairly large in some species; microconchs typically small but may be somewhat larger in some species.

Shell discoidal and fairly evolute or moderately involute; whorls compressed, typically much higher than broad, flat sided or with very gently convex flanks; umbilicus shallow, moderately wide and encircled by low but steep or nearly vertical wall and then abruptly subrounded to subangular shoulder.

Collared constrictions prorsiradiate or nearly rectiradiate on the main part of flank and markedly projected on the outer part of whorl, cutting obliquely several ribs behind them in both phragmocone and body-chamber of micro- and macroconchs.

In the major part of the phragmocone numerous ribs or subcostae develop mainly on the outer part (i.e. outer flank and venter), some of which may extend inward but are often weak, or the inner flank is nearly smooth, with or without fine lirae on the shell surface.

In the adult shell, i.e. the last part of the phragmocone and the major part of the body-chamber, ribs coarsen gradually, or become gradually distinct, some of which are longer, with intercalated and/or branched shorter ones, but in some species all the ribs are short, leaving the inner flank smooth.

The long ribs on both phragmocone and body-chamber rather rectiradiate or prorsiradiate or gently concave on the main flank, normally without sigmoid curvature, and more or less projected on the outer part.

Apertural margin of macroconch nearly smooth, with fine lirae, and the peristome gently sinuous, with projected ventral rostrum, broad and shallow ventrolateral sinus and small and shallow umbilical (ocular) sinus, without long lappet. Microconch presumably lappeted at the peristome.

Suture similar to that of *Puzosia,* but in some small species L may not be so asymmetric nor so much expanded as in typical *Puzosia*.

Discussion:—It is indeed regrettable that the type-species, *Kitchinites pondicherryanus* (Kossmat), is represented only by a single small holotype and that no subsequent example has been reported. Moreover, the observation of the holotype itself was not satisfactory. Fortunately

I examined twice (in 1953 and 1979) that specimen, which was previously kept at the Geological Society (without number) and later registered at BMNH. C 47548. The illustration by Kossmat (1897, pl. 17[6], figs. 6a—c) is fairly good but its lateral view is actually the right side for the reason of an old technique of printing. Fig. 34A in this paper is the real left side view.

The specimen is small but preserves the body-chamber for about 135°. Its dimensions (in my measurements) are shown in a table below, together with those of other species. The suture illustrated by Kossmat is the one about 180° adaptically from the last suture, i.e. at an immature stage. Therefore, the *Puzosia*-type pattern is not yet fully manifested.

In the young stage, the collared constrictions are distinct, six per whorl, and prorsiradiate, but the surface of the shell has only faint and fine lirae on the major part of flank and looks nearly smooth, but for very fine subcostae on the outer part where the constrictions are oblique to the subcostae behind them.

On the last part (about 90°) of the phragmocone the subcostae become gradually distinct and can be called ribs. On the body-chamber ribs are of moderate intensity and some of them are long and nearly rectiradiate on the main flank. All the ribs are weakly curved forward on the outer part. The constrictions on the body chamber are clearly prorsiradiate, cutting two or three ribs behind them. A constriction in younger stage shows a short lateral projection, which suggests the base of lappet worked at one time on the way of growth. I interpret that this small holotype probably represents the microconch of *Kitchinites*.

The macroconch of *Kitchinites* is represented by several specimens. The first specimen which I noticed is WW. Coll. 155 from Whangaroa (New Zealand) of *K. brevicostatus* (Marshall). Although the body-chamber is partly broken, its peristome is preserved, showing a gently sigmoidal curve on the side, although the very apex of the rostrum is not preserved. The diameter of the shell at the apertural end is 114 mm and the body-chamber occupies about 220°. A narrow marginal area between the peristome and the last constriction is nearly smooth but for fine lirae parallel to the peristome. (See Fig. 35 in p. 88.)

The neotype of *K. angustus* (Marshall) proposed by Henderson (1970, p. 34, pl. 14, fig. 1a) shows the peristome at the end and a trace of peristome in front of the collared constriction about 100° adaptically from the end, showing gently sinuous curve on the flank and projection on the venter. This specimen is certainly a macroconch. It is about 125 mm in diameter.

K. darwini (Steinmann) (1895, p. 73, pl. 5, figs. 3a, b), from the Quiriquina Beds of Chile and the Jame Ross-Seymour area of Antarctica (Howarth, 1966b, p. 59, figs. 2a, b; 3b; 4: Del Valle *et al.*, 1976; Macellari, 1986, p. 19, figs. 14·2—14·3; 17·1—17·3, 18, 19·1, 22·2), are fairly large for the genus. Although there are several good illustrations, no example shows the apertural margin and the distinction between micro- and macroconchs has not been clearly described. This species looks fairly similar to *Neopuzosia ishikawai* in the ribbing and shell-form of the late growth-stage, but the constrictions are much more projected outward in *K. darwini* than in *N. ishikawai,* cutting several ribs behind them. On the body-chamber of *N. ishikawai* the constrictions and flares are nearly parallel to the ribs. The distinction between the two species in the ribbing of immature stage is clear.

The five species from the Lower Campanian of Madagascar described under *Kitchinites* by Collignon (1961, p. 55—58, pl. 6, figs. 3, 3a, 3b; figs. 4, 4a; figs. 5, 5a; pl. 23, figs. 2, 2a, 2b; figs. 3, 3a) do not conform with the above described diagnosis. Some of them could be immature *Neopuzosia,* but I hesitate to give conclusive remarks on them for the reason of insufficient

material.

On the other hand, some more species of *Kitchinites* have been added recently, such as *K. spathi* Henderson and McNamara (1985, p. 57, pl. 4, figs. 5, 6, 9, 10, 14, 15; text-figs. 6b, c) from the Miria Formation (Maastrichtian in authors' view) of Western Australia, and *K. laurae* Macellari (1986, p. 22, figs. 19·2, 20·1—20·4, 21, 22·3), from the Maastrichtian of the Seymour Island (Antarctic peninsula).

K. angolaensis Howarth (1965, p. 386, pl. 11, figs. 4—6), from the Upper Campanian of Angola, was regarded as questionable, for it has gently sigmoidal fine ribs on the flank of young to middle-aged shell but in the late stage somewhat coarse and straighter ribs which are distinct on the outer part but subdued on the inner flank. Therefore, it can be stated that the ribbing of the young stage is rather of *Neopuzosia* type and that of the late stage *Kitchinites* type; in other words this species shows mixed characters, as Howarth has remarked.

There are now at least seven species in *Kitchinites* as they show various features. The generic diagnosis described above is the general characters which are normally common in these species, but I would admit to include in this genus an exceptional one which retains an old (or ancestral) character. In addition to the development of forward inclined, oblique constrictions on the phragmocone and body-chamber, another new character which appeared in several species of *Kitchinites* is the reduction or even disappearance of the ribs on the inner flank, with a result that distinct ribs develop mainly on the outer part of the whorl. As I evaluate this feature more significant than the ancestral character weakly remained on immature shell, I decide to refer the Howarth's species to *Kitchinites*. Spath seemed to introduce a new genus for this species. This was rejected by Howarth (1865), with whom I would agree. If one considers the diversity in evolution, rather than a single orthogenetic change, a genus should be fairly comprehensive and too much splitting should be avoided.

In this paper I have redefined *Neopuzosia* and *Kitchinites*. Thus the two taxa of generic rank can be distinguished. They express a major evolutionary trend in the late stage of the family Puzosiidae. On the records available at present, *Neopuzosia* ranges from late Coniacian to early Campanian with the maximum development in the Santonian. Its areas of distribution are the Japanese and adjacent provinces and also Europe, if Madagascar is excluded as doubtful. *Kitchinites* occurs in the Campanian and Maastrichtian of the southern hemisphere. The separation of *Neopuzosia* from *Kitchinites* is, thus, taxonomically, biostratigraphically and palaeogeographically useful.

Because of the intimate relationships of *Kitchinites* and *Neopuzosia*, some authors favour the subgeneric separation, *K.* (*Kitchinites*) and *K.* (*Neopuzosia*). I would not take much objection to this treatment, but it is difficult to trace a line of descent or branching from a species of *Neopuzosia* to that of *Kitchinites*. For this reason and for brevity I treat them as independent genera.

Dimensions of selected examples of Kitchinites

Specimen	D	U	H	B	B/H	H/h	Inv
K. pond. LS*	40.0	13.2 (.33)	17.0 (.42)	10.0 (.25)	0.59	—	—
K. pond. LS + 135°*	54.0	17.0 (.31)	22.0 (.41)	14.5 (.27)	0.66	1.47	0.50
K. darw.	187.0	65.0 (.35)	75.0 (.40)	50.5 (.27)	0.66	1.59	—
BM. C 72791	170.0	63.4 (.377	63.7 (.37)	48.0 (.28)	0.75	1.52	0.29
*K. brevi.**	55.5	18.0 (.32)	25.0 (.45)	12.8 (.23)	0.51	—	—
WW. 155*	114.0	40.0 (.35)	44.0 (.39)	—	—	—	—

WW. 155 LS*	—	—	29.0	15.0	0.51	—	—
K. angus.	74.0	27.0 (.36)	30.0 (.41)	19.0 (.26)	0.63		
K. angola.	64.0	16.5 (.26)	28.7 (.45)	much compr. sec.			
K. spat. (fig.*)	77.0	30.1 (.39)	27.7 (.36)	18.7 (.24)	0.68	1.42	0.41
K. laurae	128.9	44.6 (.35)	50.8 (.39)	38.1 (.30)	0.75	—	—

Holotype, lectotype or neotype is measured for *K. pondicherryanus, K. darwini, K. brevicostatus, K. angustus, K. angolaensis, K. spathi* and *K. laurae.* BM. C 72791: *K. darwini* by Howarth (1966b); WW. 155: *K. brevicostatus;* * measured by myself; others cited from Howarth (1965, 1966b), Henderson (1970) and Macellari (1986).

Genus *Anapuzosia* Matsumoto, 1954

Type species:—*Puzosia buenaventura* Anderson, 1938 by original designation (Matsumoto, 1954b, p. 71).

Diagnosis:—Shell medium sized or large and similar to *Puzosia* in form but comparatively more broadly whorled on the average. From fairly early middle growth-stage onward numerous long ribs develop, which arise at or near the umbilical rim, more or less sigmoidal on flank with branched and also intercalated shorter ribs on the outer part; also periodic constrictions well marked and associated flares distinct. Adult body-chamber provided with strong, rather rectiradiate major ribs at more or less wide intervals without minor ribs.

Macroconch very large and its body-chamber may be modified to have reversed subtrapzoid cross-section with somewhat divergent flanks and wide venter.

Remarks:—The diagnosis in Matsumoto, 1954b was inadequate and revised to the above in this paper.

Discussion:—Since I proposed *Anapuzosia* as a subgenus of *Puzosia,* it has been taken by several authors in describing a number of species. Renz (1972) has described five species under *P.* (*Anapuzosia*) from the Albian of Venezuela, in which an old established *Ammonites tucuyensis* von Buch, 1850 is included. Although Collignon (1961, 1963) has shown no example of *Anapuzosia* from Madagascar, *Puzosia saintoursi* Collignon, from the Zone of *Douvilleiceras inaequinodum* (Lower Albian) of Madagascar, has been assigned to *P.* (*Anapuzosia*) by Renz (1972), who has described the same species with fine illustrations from the Zone of *Hysteroceras orbignyi* (Upper Albian) of Venezuela. I would agree with Renz in this assignment. The specimens figured by Renz (1972, 1982) are all medium or small in size and no larger example with major ribs has been shown. This is a drawback and should be supplemented by future finding.

On the other hand, Marcinowski (1977) reported giant ammonites under two new species of *P.* (*Anapuzosia*) from the Upper Albian of Crimea (USSR), which he regarded as macroconchs. I would appreciate this fine result, but a find of the corresponding microconch is keenly required, as Marcinowski himself stated.

Cooper (1978) was right in criticizing my 1954 definition which depended only on body-chamber characteristics, but I would not exclude them. I should take into consideration characteristics of phragmocone and body-chamber both, generally change of characters with growth; and also characters of micro- and macroconchs both, if there is dimorphism.

Cooper (1978, p. 78) assigned *Austiniceras dibleyi* Spath, 1922 to *P.* (*Anapuzosia*) and described examples from Angola, which include fairly broadly whorled forms. This Cooper's view has been approved by Wright and Kennedy (1981). On looking at the holotype (BMNH.

C 13912) (Kennedy, 1971, pl. 14, fig. 4, misprinted as BMNH. C 10618 in the explanation; Philips, 1977, p. 23; Wright and Kennedy, 1981, pl. 2, fig. 4), from the Upper Cenomanian of England, I hesitate to transfer it from *Austiniceras* to *Anapuzosia*. Although its holotype is deformed secondarily, it seems to have fairly compressed whorl originally, as is suggested by another illustrated example (Wright and Kennedy, 1981, p. 1, fig. 2). The bifurcated ribs are none or few in them. The expansion ratio of the whorl-height is fairly high (H/h = 1.53 in holotype) and the major ribs which develop from the periodic flares on the inner whorls become more frequent on the late outer whorl. These characters are favourable for the assignment of this species to *Austiniceras*. The specimens from Angola described by Cooper (1976) and also Douvillé (1931), may represent a Cenomanian *Anapuzosia*, which may be distinct from *Austiniceras dibleyi*. My view is supported also by the restudy of *Puzosia nipponica* Matsumoto, with the result that it is now revised to *Austiniceras nipponicum* and that it is close to *A. dibleyi* of my conception. Copper did not indicate the position of the last septum on his figured specimens and disregarded dimorphism in the description. Without examining the specimens from Angola, I should reserve to give a final conclusion on this questionable species from Angola.

More serious is the problem that *Jimboiceras* Matsumoto, 1954b (p. 95) (instead of Shimizu, 1935, *nom. nud.*, see Matsumoto, 1959b, p. 21) could possibly fall in synonymy of *Anapuzosia* Matsumoto, 1954b (p. 71). *Jimboiceras*, established on the type species *Desmoceras planulatiforme* Jimbo, 1894, was clearly defined in itself, but the generic diagnosis given in 1954 (p. 95) contained an error about the adult shell. Moreover, I disregarded the ribbing on the inner whorls of *Anapuzosia*.

In the characters of the phragmocone, there seems to be little difference between *Anapuzosia* and *Jimboiceras*, but the bifurcation of ribs occur frequently on the outer flank in *Anapuzosia* and less frequently on the middle or inner flank in *Jimboiceras*. In those of the adult body-chamber there is a marked distinction between the two genera, as far as the available material is concerned.

Even in the larger macroconch of *J. planulatiforme* (to be described fully in Part II), the adult body-chamber has an ornamentation similar to that of the microconch, but for the difference at the peristome. Although its ribs and flares are gradually coarsen in the late growth stage, the strong and distant ribs of the *Anapuzosia* type do not appear.

The holotype of *Anapuzosia buenaventura* (Anderson, 1938) is only 160 mm in diameter but has strong and distant major ribs on the body-chamber without minor ones. It is regarded as a microconch by Marcinowski (1977, p. 414). This may be correct for its size, but is not convincing until the very apertural margin be confirmed. Anyhow, the marked distinction between the type species of *Jimboiceras* and *Anapuzosia* is more than specific. No peculiar modification of whorl shape occurs in the adult macroconch of *Jimboiceras*. Marcinowski (1977) has shown huge macroconch examples of *Anapuzosia* whose body-chamber has thick ribs and a broad venter.

I am now inclined to rank *Anapuzosia* as an independent genus rather than a subgenus of *Puzosia* because of its well manifested ribbing even on inner whorls. In this respect *Anapuzosia* may be closer to *Pachydesmoceras*. Incidentally, *Jimboiceras mihoense* Matsumoto, 1954 is revised to *Pachydesmoceras mihoense* in this paper (p. 134).

Occurrence:—The hitherto described species of *Anapuzosia* are rather scattered in geographical distribution, but they are mostly Albian (early to late) in age: Albian of California, Venezuela, Madagascar and Crimea; questionably Upper Cenomanian of Angola. There is a probable but undescribed example of *Anapuzosia* in Hokkaido.

Genus *Jimboiceras* Matsumoto, 1954

Type species:—*Desmoceras planulatiforme* Jimbo, 1894, from the Turonian of Hokkaido (see Matsumoto, 1959b, p. 21).

Diagnosis:—Microconch of moderate size; macroconch fairly large. Phragmocone fairly similar to that of *Mesopuzosia* in shell-form and ornamentation but generally more convex on sides with rounded umbilical shoulders and some of the long ribs bifurcate on the flank; periodic constrictions well marked and associated flares distinct. Suture of *Puzosia* type.

On the adult body-chamber the ribs coarsen and may strengthen gradually and the flares become more frequent and thicker. There is no marked difference between micro- and macroconch, except for their size and peristome characters; the macroconch larger and devoid of lateral lappets.

Discussion:—In addition to the type species, *Eocanadoceras hannai* Anderson, 1958 from California, and *J.* (?) *antarcticum* Riccardi, 1980 from Seymour Island of Antarctica may be referable to this genus.

The phylogenetic relationships of *Jimboireras* with other genera are uncertain. It may be allied to *Anapuzosia* or *Mesopuzosia,* but it differs from either of them in the characters of the adult body-chamber (especially in macroconchs; see the descriptions of respective genera). Under these circumstances I should rank *Jimboiceras* as an independent genus.

Occurrence:—So far, Turonian of the northern Pacific region and probably also Madagascar and Upper Cretaceous of Antarctica.

Genus *Austiniceras* Spath, 1922

Type species:—*Ammonites austeni* Sharpe, 1855 (original designation).

Genus *Parapuzosia* Nowak, 1913

Type species:—*Sonneratia daubreei* de Grossouvre, 1894 (original designation).

Remarks:—Wright (1957 *in* Arkell *et al.*) treated *Austiniceras* as a subgenus of *Parapuzosia* Nowak, 1913. This is followed also by Wright & Kennedy (1984, p. 59). As far as the well-known species from Europe are concerned, *Austiniceras* and *Parapuzosia* look fairly similar and their subgeneric separation may be justified.

In Japan and adjacent areas there is not enough material to discuss the problem, but I studied some examples of the two taxa in London, Paris, Austin and other places. When many species from Madagascar and North America are considered in addition to the species from Europe, I am rather inclined to follow Matsumoto (1954b), Collignon (1961), Young (1963) and Kennedy (1971) in separating *Austiniceras* and *Parapuzosia* as distinct genera, although with some doubts. Their generic characters or distinctions seem to appear in shell-form and ornamentation. The diagnosis may be written as follows:

Austiniceras. Similar to *Puzosia* in young stage but fairly involute and rather narrowly umbilicate later, increasing fairly rapidly in whorl-height. Outer whorl higher than broad and subtrigonal in cross-section, with narrowly arched venter, rather flat and convergent flanks, subangular umbilical shoulder and low but nearly vertical umbilical wall. Flares associated with narrow constrictions replaced on the outer whorl by more frequent major ribs which are gently

flexuous on the main part of flank and remarkably projected on the ventral part. Minor ribs on the outer whorl variable in length but more distinct, numerous and similarly projected on the outer flank and venter. Suture similar to that of *Puzosia*.

Parapuzosia. The type species, *Sonneratia daubreei,* was errected on syntypes, of which the illustrated one (de Grossouvre, 1894, pl. 28) is here designated as the **lectotype.** Whorl more or less higher than broad and in later stages rather ovoid in cross-section, with more or less convex flanks. Umbilicus fairly narrow to moderately wide and the umbilical rim subangular (in the type species and a few others) or less so or even rounded in many others. At least after the middle growth-stage, ribs differentiated into two types, long and thick or strong major ones and short and more numerous, minor ones, the latter of which mainly on the outer part (i.e. outer flank and venter), where all the ribs curved forward. Long ribs nearly rectiradiate or gently concave on the main part of flank. The major ribs branched into two or three minor ones as in the type species, but the branching may not be distinct in some species. In the late stage, when major ribs are well developed, constrictions disappear. On the outer whorl of huge forms the external ribs may become obsolete, whereas the major ribs persist as widely separated broad ones on the flank; finally the shell may be nearly smooth. Suture similar to that of *Puzosia*.

Austiniceras ranges from the Lower Cenomanian to Turonian in Europe and eastward contiguous regions. Collignon (1961, 1969) assigned several species from the Coniacian to Campanian of Madagascar to *Austiniceras*. I agree with him in this assignment at least on some species which I examined in Paris. Now the distribution of *Austiniceras* is extended to Japan, as Kennedy (1971) has already suggested, and probably also to Sakhalin (see description in Part II).

The species which have been referred to *Parapuzosia* occur in the Santonian and Campanian of Europe, North Africa, South Africa, U. S. A., Mexico and Curacao. No species of *Parapuzosia* has been described from Japan. Unmistakable examples of *Parapuzosia* have not been reported from the stages earlier than the Coniacian.

As to the two genera there remain some problems to be worked out. In both genera large or huge forms have been often reported, but the completely preserved specimens which show distinctly the ontogenetic changes up to the adult apertural margin are few or strictly speaking not yet found. Therefore, the distinction of macro- and microconchs is not clear. Based on available (though more or less incomplete) specimens, the shell-form of the late septate stage seems to persist to the body-chamber, without significant or abnormal modification. The major ribs also persist to the outer whorl of some huge forms, although they may gradually change in strength and distance. At the final stage of some huge forms the shell may look nearly smooth. These characters may be merely applied to macroconchs. The illustrated lectotype of *A. austeni* and that of *P. daubreei* may represent the adult microconchs, in both of which major and minor ribs are well differentiated on the body-chamber. This is, however, my presumption and more distinct dimorphic pairs should be searched for.

Another problem is that *Parapuzosia* as defined above may be polyphyletic. As a working hypothesis, some species which are now referred to *Parapuzosia* could be transferred to *Pachydesmoceras* Spath, 1922 or might be a derivative of *Pachydesmoceras*. *Parapuzosia seppenradensis* (Landois, 1895) (see Lehmann, 1976, fig. 4; also Summesberger, 1979), from the "Senonian" of Münster (W. Germany) and *P. bradyi* Miller et Youngquist (1946, p. 481, pls. 73—75), from the "Senonian" of Wyoming, well-known giant ammonites, may be such examples. Should *Parapuzosia* be defined strictly as the group of *P. daubreei* (de Grossouvre, 1894), excluding

the doubtful species as mentioned above, then *Austiniceras* would be better treated as a subgenus of *Parapuzosia*.

Genus *Grandidiericeras* Collignon, 1961

Type species:—*Grandidiericeras grandidierorum* Collignon, 1961, from the Campanian of Madagascar (original designation).

Remarks:—This genus has been recently redefined and discussed by Matsumoto and Saito (1987), who have shown huge specimens as probable examples of macroconchs in their description of *G. nagaoi* Matsumoto et Saito (1987, p. 2, figs. 1—4), from the Coniacian of Hokkaido, and inferred that Collignon's holotype may be a microconch.

The phylogenetic origin of *Grandidiericeras* is not yet clear, but the affinities of this genus may be sought in *Austiniceras* or *Anapuzosia*. For more details read Matsumoto and Saito (1987).

Genus *Bhimaites* Matsumoto, 1954

Type species:—*Ammonites bhima* Stoliczka, 1865 (see remarks below) (by original designation, Matsumoto, 1954b, p. 113).

Diagnosis:—Shell involute and fairly narrowly umbilicate, with fairly high expansion of radius or whorl-height. Whorls compressed, with flat or slightly convex flanks which converge to arched venter. Constrictions or periodic flares frequent but narrow, somewhat prorsiradiate or gently flexuous and sometimes faint on flank and remarkably projected and distinct on venter. Surface of shell nearly smooth or very weakly ornamented, with or without gently flexuous low lirae on flank and/or fine and faint subcostae on the outer part of whorl. Suture similar to that of *Puzosia* in having large and asymmetrically tripartite L, with expanded branches; but auxiliaries descending rather gradually and not so abruptly as in *Puzosia*. Dimorphic pair probably existed but not yet clearly recognized.

Discussion:—The species which I refer to *Bhimaites* are as follows:

B. bhima (Stoliczka, 1865): Albian of South India

B. stoliczkai (Kossmat, 1898): Lower Cenomanian of South India and Madagascar (Collignon, 1961); Upper Albian of Iran (Douvillé, 1904), South Africa (Crick, 1907; Venzo, 1936), Sardinia (Wiedmann and Dieni, 1968), Spain (Wiedmann and Boess, 1984) and Venezuela (Renz, 1972; 1982)

B. subtilis (Crick, 1907): Cenomanian (?) of South Africa

B. australis (Venzo, 1936): Upper Albian-Lower Cenomanian of South Africa

B. aontzyensis Collignon, 1961: Lower Cenomanian of Madagascar; Upper Albian of Venezuela (Renz, 1972; 1982)

B. analabensis Collignon, 1961: Coniacian of Madagascar

B. sp. nov. (to be established below): Turonian of Japan

? *B. decemsulcatus* (Collignon, 1950): Albian of Madagascar

? *B.* sp.: Lower Cenomanian of England (Wright and Kennedy, 1984)

Ammonites bhima Stoliczka was established on syntypes which I examined at the Geological Survey of India (= GSI), Calcutta. GSI. No. 272 (Stoliczka, 1865, pl. 69, fig. 2, 2a, 2b), from Morraviatoor, is here designated as the **lectotype.** Its dimensions (in mm) are as follows:

Position	D	U	H	B	B/H
(1)	140.0 (1)	30.0 (.21)	68.0 (.49)	49.0 (.35)	0.72
(2)	107.5 (1)	23.7 (.22)	50.0 (.47)	35.0 (.33)	0.70

(1): at the last septum a little behind the preserved end; (2): about 90° prior to (1)

The last part of its phragmocone is elongate ovoid in section, having gently convex flanks with the maximum breadth below the mid-flank. The younger part of the phragmocone has nearly flat flanks. The umbilical wall is steep and the umbilical shoulder subangular to narrowly rounded. The outer whorl overlaps about two thirds of the inner whorl. The ratio of increase in whorl-height or in radius is 1.61 per half whorl. Should the body-chamber be longer than 180° the entire shell diameter would exceed 230 mm. This suggests that the lectotype may represent the phragmocone of a macroconch, but the character of the lost body-chamber is not known.

In shell-form and nearly smooth surface, *B. bhima* is seemingly similar to a certain species of *Desmoceras,* e.g. *D.* (*Pseudouhligella*) *ezoanum* Matsumoto, but the asymmetrically tripartite large L in its suture, dense and fine subcostae discernible on some parts of its venter and its larger size are favourable to refer *B. bhima* to the Puzosiidae. It is distinguished from any species of *Puzosia* by its greater involution, narrower umbilicus, higher ratio of increase in whorl-height, weaker and narrower but more frequent constrictions, faintly ornamented or nearly smooth surface and gradually (instead of abruptly) descending auxiliaries in its suture.

Leanza (1970, p. 219) noted that *Puzosia vegaensis* Leanza, 1970 (p. 218, figs. 15, 16), from the Albian of the southern Andes, looks to be intermediate between typical species of *Puzosia* and *Bhimaites.* I should take notice that it is also similar to, if not quite identical with, *Melchiorites, emerici* (Raspail).

A smaller syntype, GSI. No. 271, illustrated by Stoliczka (1865, pl. 69, fig. 1, 1a) under *A. bhima* is doubtful in the identification, for it has a somewhat wider umbilicus (U/D = 0.29) and less compressed whorl (B/H = 0.79) which is broadest near the umbilical shoulder. Its flanks are somewhat convex and not so flattened as those of the inner whorls of the lectotype. It is an internal mould and the sutures are well exposed. It may be an atypical species of *Bhimaites,* but its similarity to a certain species of *Melchiorites* is worthy of note.

In some illustrated specimens of *B. aontzyensis* (e.g. Renz, 1972, pl. 7, fig. 3) the subcostae are weak but more distinct than those of *B. bhima.* A larger example of this species illustrated by Renz (1972, pl. 8, fig. 4; 1982, pl. 6, fig. 6) shows moderately strong ribs of unequal length separated by wider interspaces on its body-chamber. This may represent an adult macroconch. It should be noted that this ornament is somewhat similar, if not identical, to that of the adult body-chamber of a certain species of *Pachydesmoceras* rather than to that of *Puzosia.*

A microconch with the apertural margin preserved has not yet been confirmed in any species of *Bhimaites.*

The available evidence is not sufficient to interpret the phylogeny of *Bhimaites,* but on the basis of the above observations I presume as a possible working hypothesis that *Puzosia, Bhimaites* and *Pachydesmoceras* may have diverged from a common ancestor (probably some species of *Melchiorites*) and evolved in parallel. I should confess, however, that more materials are wanted especially those from the Lower Albian to examine this or other hypothetical views. Anyhow, I prefer to regard *Bhimaites* as being independent of *Puzosia* rather than a subgenus of the latter. Whether the microconch apertural margin of *Bhimaites* is similar to that of *Puzosia* or *Desmoceras* or otherwise is a question to be worked out.

Occurrence:—From the records at the beginning of the discussion, it can be stated that *Bhimaites* distributed mainly in the shelf seas or marginal parts of the continents of southern hemisphere, i.e. the break-up Gondwana Land, and were fairly common in the Upper Albian and Lower Cenomanian. Its rare occurrence in the Turonian of Japan is noteworthy.

Genus *Pachydesmoceras* Spath, 1922

Type species:—*Ammonites denisonianus* Stoliczka, 1865 (from the Uttattur Formation [=Ootatoor or Utatur Group] of South India (see Matsumoto, 1987).

Diagnosis:—Shell in the early growth-stage more or less similar to that of *Puzosia*; sooner or later in the middle growth-stage onward the whorl inflated gradually to form suboval to subcircular section, with more or less rounded umbilical shoulder, the ribs also coarsen gradually but of unequal length, of which some of the long ribs develop from the periodic flares of the preceding stage.

The large outer whorl of the adult stage normally ornamented with strong ribs which are subradial to concave on the main part of the flank and more or less curved forward with projection on the outer part. In the late growth-stage of some forms the ribs strengthen to a moderate degree and then weaken gradually, followed finally by the nearly smooth body-chamber, which may have peculiar inflations.

Suture similar to that of *Puzosia.*

Remarks:—Completely preserved apertural margin has not yet been observed in microconchs of *Pachydesmoceras,* but two forms of dissimilar sizes are well recognized in several species of *Pachydesmoceras.* In some examples of the large form a peculiar change in the shape of shell occurs in a certain part of the outer whorl. (For example see the description of *P. pachydiscoide*). Therefore, the two forms can be regarded as representing the micro- and macroconchs respectively. The loss of sigmoid curvature of the ribs on the outer whorl gives us a doubt that a microconch might lack lappets.

Discussion:—The following species, with some amendment in this paper, are comparatively better known and can be regarded as typical examples of this genus. The hitherto known stratigraphical range and geographical distribution are also recorded for each of them.

(1) *P. denisonianum* (Stoliczka, 1865): Upper Albian and Cenomanian; South India, Iran, Madagascar, Japan and Germany
(2) *P. kossmati* Matsumoto, 1987: Lower to Middle Turonian; South India and Japan
(3) *P. pachydiscoide* Matsumoto, 1954: Middle to Upper Turonian and Coniacian; Sakhalin, Japan, California, South India and Madagascar
(4) *P. linderi* (de Grossouvre, 1894) (in the sense of Collignon, 1961; 1966): Upper Turonian and Lower Coniacian; Madagascar, Marocco and France

There are several other species which are allied to but not identical with some of the above four. So far, they have been locally known. Examples are as follows:

(5) *P. alimanestianui* (Popovici- Hatzeg, 1899): Upper Albian- Lower Cenomanian (?); Roumania and south-eastern France
(6) *P.* aff. *kossmati* Matsumoto (this paper): Upper Cenomanian; Japan
(7) *P. kamerunense* (von Koenen, 1898) (see Reyment, 1955): Lower Turonian; southern Cameroons

(8) *P.* aff. *P. denisonianum* [=*Puzosia denisoniana* of Zimmermann, 1912]: Turonian (?) and (?) Upper Cenomanian; northern Germany and (?) southern England
(9) *P. hourcqui* Collignon, 1961: Upper Turonian; Madagascar
(10) *P.* sp. indet. of Matsumoto (1959a): Upper Albian; Alaska

The above listed ten species constitute a major group of *Pachydesmoceras* in that they are directly or indirectly related to one another. On the other hand, the following three species seem to deviate considerably from this major group, as will be discussed in the description of (13).
(11) *P. rarecostatum* Collignon, 1961: Lower Cenomanian; Madagascar
(12) *P. radaodyi* Collignon, 1964: Middle Cenomanian; Madagascar
(13) *P. mihoense* (Matsumoto, 1954): Upper Coniacian-Lower Santonian; Sakhalin and Japan

On the other hand fine and dense ribs unusually persist to the large late part of the phragmocone in a rare species
(14) *P. iruteri* van Hoepen, 1968: Coniacian; South Africa.

The available specimens of *Pachydesmoceras* are mostly large. The characters of a young shell and their change with growth are known in *P. kossmati* (see Kossmat, 1898) and *P. pachydiscoide* (see Matsumoto, 1954b, p. 102). The fact that the shell of the early growth-stage is more or less similar to that of *Puzosia* (see the above generic diagnosis) is not particular to *Pachydesmoceras* but may be observed in several other genera. This is, however, significant for *Pachydesmoceras* in that the pachydiscid aspects are revealed with growth in the shell-form (broadening whorl with convex flanks) and ornamentation (coarsening and strengthening ribs with decrease or disappearance of sigmoid curvature). The suture is kept to be *Puzosia*-type throughout growth.

The phylogenetic origin of *Pachydesmoceras* is not clear. As Kossmat (1898) suggested, the ultimate origin of this genus may be in *Melchiorites* Spath, 1923, but an unmistakable example of *Pachydesmoceras* has not been obtained from the lower part of the Albian stage. The genus may have branched either from the main stock of *Puzosia* or from *Anapuzosia* or the three genera may have common origin in such a form as *Melchiorites*. The evolutionary line from a species to another has not yet been traced for any twos of the above genera. In fact, *Anapuzosia hottingeri* (Collignon, 1966) (see Renz, 1972), from the lower Upper Albian (*Dipoloceras cristatum* beds) of Marocco, was described originally under *Pachydesmoceras* (Collignon, 1966, p. 14, pl. 2).

Occurrence:—Summarizing the afore-mentioned records, *Pachydesmoceras* ranged from sometime in the Albian to the Santonian and was widespread mainly in the Indo-Pacific region, extending from time to time beyond that region.

Genus *Lytodiscoides* Spath, 1922

Type species:—*Pachydiscus conduciensis* Choffat, 1903 (from the Cretaceous of Mozambique) (original designation by Spath, 1922, p. 126).

Diagnosis:—Shell very large; outer whorl rounded in section, encircling the umbilicus of moderate width.

Inner whorls ornamented with periodic flares and/or constrictions and also intervening ribs of unequal length; outer whorl provided with long ribs at moderate intervals, alternating with one or a few, more or less shorter ribs; longer ribs nearly radial or gently concave on the inner flank and gradually curved forward on the outer flank in parallel with shorter ones; all the ribs

cross the venter with broadly convex curve.

On the body-chamber the major ribs strengthen, becoming more rigid with decrease of curvature, and provided with the umbilical and ventrolateral tubercles which are spinose or stretched vertically (i.e. at right angle to the flank) to long rods at certain points.

Suture similar to that of *Puzosia*.

Discussion:—I have not seen the actual specimens of the type species and depend on fine illustrations and precise descriptions by Choffat (1903, p. 18; pls. 2, 3; pl. 4, D, L2, L3; pl. 5, fig. L1; frontispiece). The eight specimens are more or less incomplete but complementary with one another, of which the better preserved one indicated as H is designated as the **lectotype.**

Spath (1922) considered this species as a special offshoot of *Pachydiscus* (called *Parapachydiscus* at that date), but it is evidently a member of the Puzosiidae because of its sutural pattern and similarity to a certain species of *Pachydesmoceras* in the phragmocone. In fact the shell before the pre-tuberculate stage resembles the phragmocone of *P. denisonianum* as represented by such a specimen as GSJ. F3469 from Hokkaido, although the ribbing at the corresponding growth-stages is different in detail (see the description in this paper). The huge lectotype of *P. denisonianum* has only thick but not much elevated major ribs at wide intervals on its body-chamber.

Choffat emphasized the huge size of the shell; even the smallest specimen (B) is 370 mm in diameter and is septate at its preserved end. Therefore, the presence or absence of a dimorphic pair in *Lytodiscoides* has yet to be worked out, as in other cases of the large puzosiids which have strong or peculiar ornaments on the body-chamber.

Occurrence:—Cretaceous of Mozambique. The ammonites from Conducia described by Choffat (1903) indicate the ages from late Albian to Cenomanian. No example has been obtained from Hokkaido.

Genus *Achilleoceras* van Hoepen, 1951

Type species:—*Achilleoceras erasmusi* van Hoepen, 1951 (from the Upper Albian of South Africa) (original designation by van Hoepen, 1951, p. 345).

Diagnosis:—Shell very large; whorls higher than broad and subelliptical in section for the most part with moderately rounded venter and gently convex to rather flat flanks. Umbilicus fairly narrow and surrounded by vertical but low wall and subangular to abruptly subrounded shoulder. Ornate main part of the body-chamber suboval in section with flanks converging to the median summit of the narrowly arched venter.

Phragmocone in the late growth-stage ornamented with frequent and long, major ribs and numerous, crowded, minor ribs of unequal length; the major ribs rising from the umbilical margin, subradial or sometimes gently sigmoidal on the main part of the flank and may be branched into minor ribs on the outer part; minor or narrower ribs gently curved forward at about the ventrolateral part, crossing the venter with a broadly convex curvature.

The body-chamber ornamented with several umbilical and ventrolateral tubercles on the distal part, some of which are stretched vertically to long rods; rectiradiate major ribs with umbilical bullae and also mid-ventral crest for about a quarter whorl on the adoral part. Numerous, crowded, narrow or minor ribs persisting onto the body-chamber, where they run radially with decreasing or loss of forward curve on the outer part and may be even curved somewhat backward on approaching the crested summit of the venter.

Discussion:—Regrettably I have had no opportunity to look at the holotype (by monotypy) of the type species of this genus, but on the ground of descriptions and illustrations by van Hoepen (1951, p. 345, figs. 1—3), excluding some inadequate part, I have given the above diagnosis.

In the first edition of the *Treatise* Part L (Arkell *et al.*, 1957, p. L365), *Achilleoceras* van Hoepen, 1951 was regarded as a synonym of *Lytodiscoides* Spath, 1922, but I am not in favour of this treatment and should like to keep it as an indpendent and valid genus. As I discuss in another page, *Lytodiscoides* is evidently allied to the genus *Pachydesmoceras*. Although *Achilleoceras* resembles *Lytodiscoides* in the presence of rectiradiate major ribs and several elongate tubercles on the body-chamber, there are unnegligible distinctions between them. In the later growth-stages of *Lytodiscoides*, the ribs coarsen and strengthen gradually and normally alternately long and short as in *Pachydesmoceras*. In *Achilleoceras* of the same growth-stages, numerous, narrow and dense ribs persist to the body-chamber and some of the major ribs are branched on the outer flank into two or three ribs which are as fine as minor ribs. This ornamentation is similar to that of *Austiniceras* Spath, 1922. As to the shell-form this genus can be said to be somewhat similar to *Austiniceras* in its rather flat or less inflated flanks. Moderately rounded venter may occur in some species of *Austiniceras,* e.g. *A. nipponicum* (Matsumoto), and the narrowly arched venter with convergent flanks in the adoral part of the body-chamber of *Achilleoceras* resembles the typical whorl shape of *A. austeni* (Sharpe).

As the hitherto known species of *Austiniceras* occur in the Cenomanian and later strata, I would not state that *Achilleoceras* (of late Albian) was offshooted from *Austiniceras* but suggest the close affinity. It may have a common origin—say in a certain subgroup of *Anapuzosia*. Large specimens of *Austiniceras* are recorded (Wright and Kennedy, 1984, p. 60), but a completely preserved specimen up to the apertural margin has not been known. Therefore, it is necessary to get more examples of better preservation of *Achilleoceras* and *Austiniceras* both.

The rod-like or longly spinose tubercles on a distal part of the body-chamber may work for keeping balance of buoyancy during the nekto-planktonic life period of the adult animal. Such ornaments occasionally appear in different groups, e.g. *Solenochilus* and *Acanthonautilus* in the Carboniferous Nautilida, *Anapachydiscus fascicostatus* (Yabe et Shimizu) (see Matsumoto, 1984b, p. 14) in the Ammonoidea. Similar ornaments in *Achilleoceras* and *Lytodiscoides* may be homoeomorphy within the same family Puzosiidae.

The functional meaning of the crest on the distal part of the body-chamber in *Achilleoceras* has to be worked out. As in other large puzosiid genera with strongly ornate body-chambers, dimorphic pairs have not yet been clearly known either in *Achilleoceras*. If the described form is an adult female, as is likely so, she may have come to a shallower shelf seas in a limited time of egg-laying. The ventral crest may have been favourable for her to settle herself on the bottom sediments. This is, however, a speculative working hypothesis. Incidentally, a dimorphic pair has not yet been confirmed either in *Austiniceras*. Could *Achilleoceras* be paired with some *Austiniceras*? Probably no, unless some example of *Austiniceras* be found from the Upper Albian.

Occurrence:—Apparently rare in the Upper Albian of South Africa. In view of the laborious work to be required in collecting and developing this kind of huge and delicately ornamented form as explained at length by van Hoepen (1951, p. 345), the apparent rareness may owe at least partly to failure or some deficiency in our field work, or the animal may have come only occasionally to the shallow part of the sea. Anyhow, no example has been found from Hokkaido.

Genus *Epipuzosia* nov.

Type species:—*Epipuzosia maya* sp. nov. (to be described in Part II), from the Turonian of Hokkaido.

Diagnosis:—Shell very large, with moderate involution and umbilicus of moderate width. Whorls expanding with moderate ratio and suboval in section, broadening gradually with growth, with gently convex flanks, rounded venter and steep, nearly vertical wall.

Inner whorl nearly smooth or weakly ribbed, with faint periodic flares or constrictions. The outer whorl, i.e. the last part of the phragmocone and the body-chamber, weakly ornamented with button-like low knobs, which are aligned at fairly wide intervals on the sloping ventrolateral shoulder, and also very low radial ribs, which occur in the main part of the flank normally corresponding to and extending inward from the ventrolateral nodes, whereas the outer part entirely smooth.

Suture similar to that of *Puzosia*.

Remarks:—In addition to the type species from the Turonian of Japan, there is possibly one more species. That is represented by the specimen from the Cenomanian of the Swiss Jura described under *Pachydesmoceras* aff. *denisonianum* by Renz (1976), who did not take notice of the ventrolateral knobs.

A fairly large but incompletely preserved specimen from England, BMNH. C3116, illustrated as *Puzosia* (*Puzosia*) sp. by Wright and Kennedy (1981, p. 18, text-fig. 8) has faint major ribs and weak ventrolateral nodes on the outer whorl and periodic flares and intervening weak ribs of unequal length on the visible part of the inner whorl. On the ground of these characters I would suggest that this may be another example of *Epipuzosia*. It was unlocalized but the authors believe to be from the Plenus Marls, Upper Cenomanian *Metoicoceras geslinianum* Zone of south-eastern England. Better preserved specimens should be searched for to confirm the suggestion and to make clear the specific characters.

Comparison:—This genus is similar to some species group of *Pachydesmoceras* in shell-form but distinguished by its much weaker ornaments in the late growth-stage. The button-like knobs at the ventrolateral shoulder of the outer whorl are characteristic of this genus. Major ribs may be discernible on the main flank of the outer whorl, but they are much weaker than those in the late growth-stage of *Pachydesmoceras*.

Occurrence:—So far, the genus is know to occur in the Turonian of Hokkaido (northern Japan) and the Cenomanian of the Jura Mountains (Switzerland) and England (?).

Genus *Hyperpuzosia* nov.

Type species:—*Hyperpuzosia tamon* sp. nov. (described in Part II), from the Albian of Hokkaido.

Diagnosis:—Adult shell large and broadly whorled. Inner whorl faintly constricted; otherwise smooth or with weak subcostae on the outer flank and venter.

Major radial ribs appear at wide intervals on the flank of the last part of phragmocone and strengthen on the body-chamber with remarkable hypernodosity, *i.e.* horn-like culmination, at the ventrolateral shoulder, separated by wide and concave interspaces. Venter of the body-chamber broadly arched and crossed by much lowered and broadened extensions of the ribs; it may sometimes have a faint spiral elevation along the median-line.

Suture similar to that of *Puzosia.*

Remarks:—A dimorphic pair has not yet been ascertained in the type species.

Discussion:—With respect to the strong development of major radial ribs in the mature stage, this genus is indeed similar to *Anapuzosia,* but the latter has distinct periodic flares and/or constrictions and numerous long and short ribs of the secondary order, which develop at the latest in the middle aged shell and well discernible even on the exposed part of the inner whorls within the umbilicus of the adult shell.

Up to the middle growth-stage this genus resembles *Puzosia* in a strict sense, but its constrictions are not well marked and rather rectiradiate on the flank, with more or less projection on the outer part, and on the average its whorl is comparatively broader. Some of the broadly whorled species described under *Puzosia,* e.g. *P. decaryi* Collignon, 1961 (p. 31, pl. 4, figs. 1—3), from the Lower Cenomanian of Madagascar, may represent the phragmocone of *Hyperpuzosia,* although I should defer the conclusion until the adult body-chamber be known. As far as the well preserved adult shells are concerned, *Hyperpuzosia* is quite distinct from *Puzosia.*

Someone may favour to affiliate *Hyperpuzosia* to a subgenus of *Puzosia,* but I am inclined to consider that *Hyperpuzosia, Puzosia, Anapuzosia, Pachydesmoceras* etc. may have evolved in diverging or radiating ways from a common ancestor. They are well distinguished, when the preservation is favourable. Therefore, I treat *Hyperpuzosia* as an independent genus, although it may be rather a specialized offshoot from the main stock of the Puzosiidae.

The large specimens illustrated by Jacob (1908, p. 38, pl. 16, figs. 2—4) under *Desmoceras* (*Puzosia*) *mayorianum* are not referred to *Puzosia* nor to *P. mayoriana* (d'Orbigny) and probably a species of *Hyperpuzosia.* According to Jacob, that species occurs in the Lower and Middle Albian (*tardefurcata* and *dentatus* Zones) of "Balme de Rencurel (Isere)", southeastern France. Therefore, *Hyperpuzosia* may have offshooted fairly early in the Albian age.

The broadening outer whorl of *Hyperpuzosia* reminds us that of *Pachydesmoceras,* but in *Pachydesmoceras* the whorl broadens gradually with growth, taking the oval, instead of subtrapezoid, outline in cross-section. In *Pachydesmoceras* the ribs of the inner whorl gradually coarsen to those of the outer whorl but are not so strong and devoid of such hypernodosity as that of *Hyperpuzosia.* The inner or middle-aged whorl of *Pachydesmoceras* has numerous long ribs and distinct flares and/or constrictions, whereas that of *Hyperpuzosia* looks nearly smooth, with only weak and short riblets on the outer part and faint flares. In this respect *Anapuzosia* is closer to *Pachydesmoceras* than to *Hyperpuzosia.*

The available material is yet insufficient to trace the phylogenetic origin of *Hyperpuzosia.* The presumed common ancestry with *Puzosia, Pachydesmoceras, Anapuzosia* and *Bhimaites,* mentioned above, could be sought in such a genus as *Melchiorites* Spath, 1923, but this is still a working hypothesis.

Occurrence:—*Hyperpuzosia* is known so far to occur in the Albian of Japan and France. Its more widespread distribution and further extended range should be worked out.

Genus ***Pteropuzosia*** nov.

Type species:—*Pteropuzosia kawashitai* sp. nov. (to be described in Part II), from the Turonian of Hokkaido.

Diagnosis:—Very large shell, of which the phragmocone resembles that of *Mesopuzosia* in the suture, shell-form, periodic constrictions and ribbing. On the last part of the phragmocone, the ribs weaken, tending to disappear, and the constrictions and associated flares remain faintly, whereas very low and broad major bulges may appear.

The body-chamber much broader than the phragmocone and provided with at least two pairs of ear- or wing-like large protuberances on which several coarse ribs and/or nodes may be superimposed. Where the wing-like protuberances develop, the whorl is especially broad, the venter provided with a blunt keel-like median elevation, and the umbilical wall very high.

Remarks:—In addition to the type species there seems to exist at least one more species from the Turonian of Hokkaido, but the specimens available at present are too fragmentary to establish a new species.

Discussion:—*Pteropuzosia* differs from *Anapuzosia* in its more compressed and less rounded inner whorls on which ribs are not bifurcated but as a rule alternately long and short. In other words it is more similar to *Mesopuzosia* in the characters of the phragmocone. So far as the type-species is concerned, the ribs on the phragmocone are not sigmoidal, but non-sigmoid ribs sometimes occur in certain species of *Mesopuzosia*. The simply arcuate ribs are common in typical species of *Pachydesmoceras,* but in the middle to late growth-stages of *Pachydesmoceras* the ribs are coarser and stronger and the whorl broadens more gradually in comparison with *Pteropuzosia*.

The body-chamber with the diagnosis described above is characteristic of *Pteropuzosia*.

On the basis of the above comparison, I am inclined to regard *Pteropuzosia* as an offshoot of *Mesopuzosia,* although the direct evidence of the derivation from a species to another is yet insufficient. Should this presumption be warranted, it would follow that the cladistic evolution of *Pteropuzosia* occurred nearly simultaneously or immediately after the first appearance of *Mesopuzosia* from *Puzosia*.

As to *Pteropuzosia* a dimorphic pair has not yet been confirmed. If the above phylogenetic relationships were warranted, the described large form with peculiar characters would represent the macroconch, whereas the microconch might be similar to that of *Mesopuzosia*.

The two pairs of wing-like protuberances at the ventrolateral shoulders of the body-chamber must have worked in a particular way during life. I would compare this body-chamber with a hydrofoil and imagine that the adult female of *Pteropuzosia* could run with a high speed on the sea-water. Also the two pairs of large protuberances may have been favourable to settle herself on the bottom sediments at the time of repose or possibly for laying eggs on a something.

Occurrence:—So far, Turonian of Hokkaido. I would expect, however, much wider distribution. (See also description of the type species.)

PART II
DESCRIPTIONS OF SPECIES

By

Tatsuro MATSUMOTO, with collaboration of Takemi TAKAHASHI,
Yoshitaro KAWASHITA, Kikuwo MURAMOTO, Masatoshi KERA,
Yasuji KERA, Toshio SHIMANUKI, Minoru YAMASHITA and Hakuji KOKUBUN

Introduction

In Part II species of the Puzosiidae from the Cretaceous strata of Hokkaido are described. Although T. Matsumoto is chiefly responsible for the description, for some species the coauthorship is taken with the persons who have worked to a considerable extent in the field and laboratory, except in the case when a new species is dedicated to a particular person.

Neopuzosia haboroensis Matsumoto et Inoma, 1972, *Mesopuzosia densicostata* Matsumoto, 1954 (see Matsumoto, 1984b) and *Grandidiericeras nagaoi* Matsumoto et Saito, 1987 are omitted from this paper, since they have been described or redescribed recently. Also *Neopuzosia ishikawai* (Jimbo, 1894) is briefly mentioned in the discussion of *N. japonica* (Spath).

To get an adequate concept of a species, one should depend on the material which represents populations. It is, however, fairly difficult to know the original population in the fossil material. In the case of the Cretaceous of Hokkaido, fossil puzosiids mostly occur in the sediments of muddy facies, but if one scrutinized more carefully there would be varieties in the sedimentary facies and mode of occurrence, as H. Maeda (oral communication) preliminarily remarked. Such problems are not dealt with in this paper and left for future studies.

Even if numerous specimens were obtained from a given bed, they may not represent a population of a single species especially when smaller septate shells were predominant in a sandy bed of near shore facies. In such a case nuclear parts of more than one species of dissimilar habitats or ecological conditions may have been transported and embedded in the same bed.

In the case of large or huge forms, the original population in life may have been distributed in a wide extent, exceeding a sight of a palaeontologist. In some lucky cases, as in the extensive exposures in the uppermost reaches of the River Pombets or those of the River Ikushumbets, we notice the fossil population of a large species in a limited zone of strata.

Anyhow, in this work the extent of variation in a given species is rather roughly described and further details are left for future works.

Systematic Descriptions

Suborder Ammonitina Hyatt, 1889

Superfamily Desmoceratacеae Zittel, 1895

Family Puzosiidae Spath, 1922

Genus *Puzosia* Bayle, 1878

Puzosia subcorbarica Matsumoto

(By T. Matsumoto and T. Takahashi)

Figures 1—2

1954b. *Puzosia subcorbarica* Matsumoto, p. 73, pl. 3, fig. 1; pl. 12, fig. 1.

Holotype:—UMUT. MM 7639 [=I-370] (Matsumoto, 1954b, p. 73, pl. 9, fig. 1), from a point a little above the Ikushumbets gorge.

Diagnosis:—Shell rather evolute with less than a half overlap of whorls and umbilicus of moderate width. Constrictions well marked, fairly frequent and gently flexuous on flanks. Whorl somewhat compressed, with flat and parallel flanks, low but vertical umbilical wall and moderately arched venter. Numerous, fine and projected ribs on outer part of septate whorl in late growth-stage, but so weak in earlier stages that shell surface looks nearly smooth. Suture as for the genus.

Microconch, with lappets at peristome, moderate in size, about 90 mm in diameter of the studied specimen. Ribs and constrictions on its body-chamber similar to those on phragmocone.

Macroconch about four times as large as microconch, showing high rate of whorl expansion and blunt radial major undulations at wide intervals on nearly smooth body-chamber.

Dimensions:—

Specimen	D	U	H	B	B/H	H/h
Holotype	150.5	48.8 (.31)	63.1 (.42)	43.5 (.29)	0.69	1.63
TTC. 490203	87.0	32.0 (.37)	*c.* 31 (.36)	—	—	—
〃 (−90°)	72.0	27.0 (.37)	26.5 (.37)	18.5 (.26)	0.69	1.43

Observations:—The original description (Matsumoto, 1954b, p. 73) is essentially correct, being applied also to the subsequently obtained specimens. The additional knowledge is concerned with the dimorphic pair. An example of microconch of this species is TTC. 490203, measured above and illustrated (Fig. 1A—B). The preserved part of the lappet is quite similar to the basal part of the tongue like elongated lappet which is well preserved in three examples (GK. H5665, TTC. 530806 and MCM. A111—2) of *Mesopuzosia pacifica* Matsumoto (see Matsumoto *et al.*, 1972, text-fig. 9; this paper Figs. 8A—B, 9A). The shorter ventral projection, i.e. rostrum, is not well preserved in TTC. 490203. This body-chamber occupies about 240°. In addition to the constriction at about the end of phragmocone there are three more constrictions on the body-chamber, with the last one immediately behind the apertural margin. The characteristic shell-form, ribbing and constriction of this species continue from the late part of phragmocone to the body-chamber without significant change.

Takahashi collected the above specimen at Nishi-katsura-zawa on the western wing of the Ikushumbets anticline, whereas the holotype came from a nearby locality on the main stream of the Ikushumbets. At loc. Ik 2030c, left bank of the River Pombets on the northern

Figure 1. *Puzosia subcorbarica* Matsumoto. →

A—B: microconch, TCC. 490203 from Nishi-katsura-zawa, Ikushumbets valley (Coll. T. Takahashi), showing the apertural margin, scale-bar = 10 mm. C: *P. subcorbarica,* macroconch, GK. H9627, plaster cast from the external mould in shale, loc. Ik 2030c, the River Pombets, tributary to the River Ikushumbets (Coll. H. Okada, M. Arita and T. Matsumoto); bar = 30 mm.

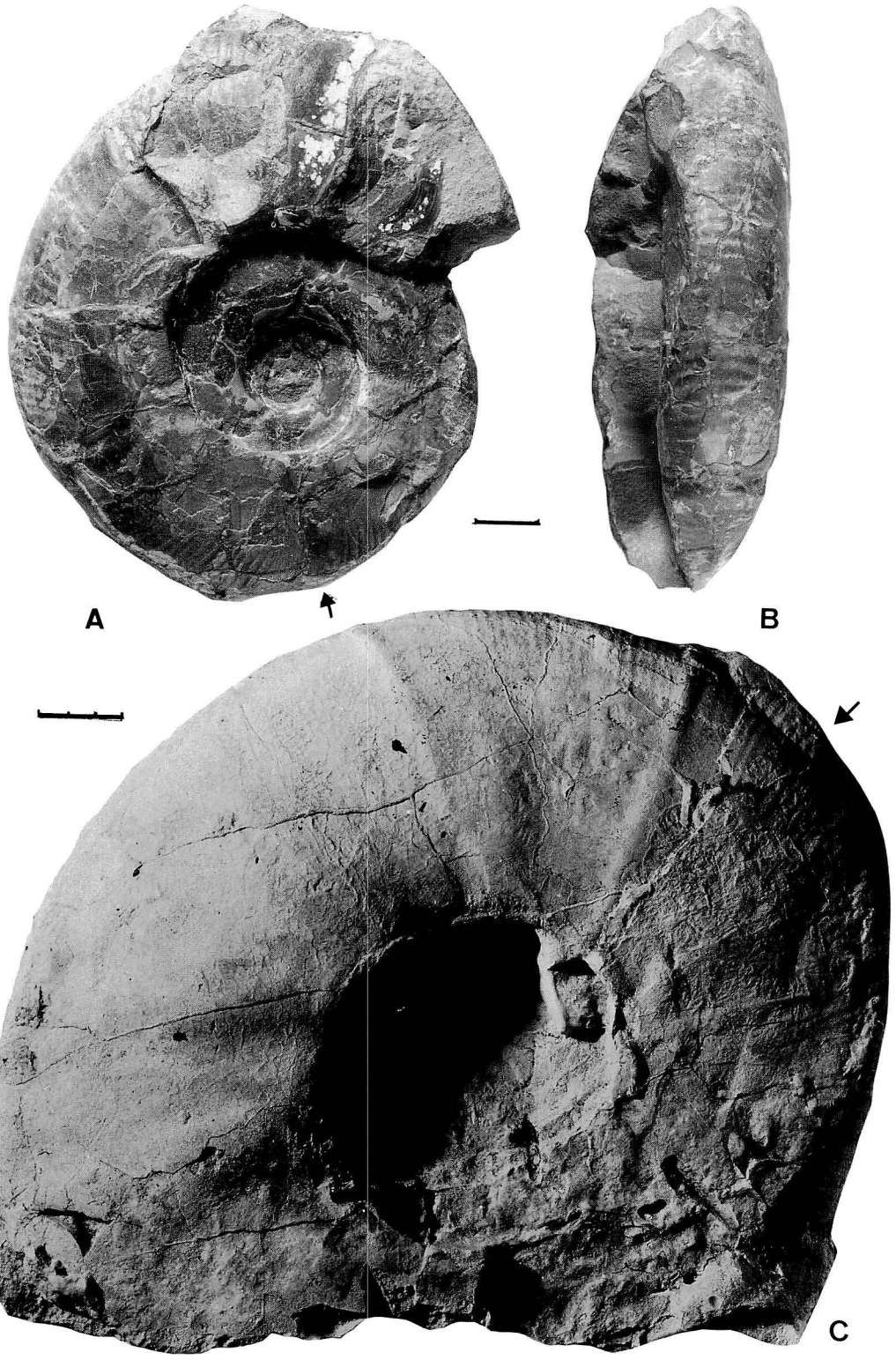

A
B
C

Figure 2. *Puzosia subcorbarica* Matsumoto.
A—C: inner whorl of macroconch, GK. H8105, from the upper reaches of the Pombets (Coll. Yamatani); bar = 10 mm.

extension of this zone, one of us (T.M.) found, together with Drs. H. Okada and M. Arita, an external mould of a larger shell, whose plaster cast is GK. H9627. Y. Kawashita collected from the same bed another specimen which is quite similar to the holotype. The larger specimen, GK. H9627 (Fig. 1C) is about 350 mm in diameter at the preserved end (150° point) of the body-chamber, but there is a trace of the additional last part of body-chamber for about 90°. The entire shell with body-chamber of 240° would be about 400 mm in diameter. Its last whorl is more involute and its umbilicus is relatively less wide (U/D = 0.29) than in the smaller holotype and other "typical" specimens of *P. subcorbarica,* but its umbilical wall is vertical with a subangular shoulder as in the latter. The fine ribs of *subcorbarica* type are on the ventral half of the phragmocone and persist to the posterior part of the body-chamber (for about 30°) and the weak and gently flexuous flares which correspond to the periodic constrictions persist to the same part. The main part of the body-chamber is nearly smooth but for low and broad major radial ribs on the inner half of the flank at wide intervals (3 per 90°). There is no remarkable change in shell-form, but the flank of the body-chamber is slightly convex as compared with the nearly flat side of the inner whorls and the whorl expands at a high rate.

On the evidence of the occurrence with and general similarity to the "typical" or previously known *Puzosia subcorbarica,* this large specimen most probably represents the macroconch of the same species. As the holotype is fairly larger than TTC. 490203 (a microconch) but smaller than GK. H9627 (above described macroconch) and has still fine ribs, it may represent a macroconch at a middle growth-stage. GK. H8105 (Fig. 2) is wholly septate and probably a nuclear part of a macroconch.

Comparison:—Marcinowski (1980) mentioned, in the description of *Puzosia planulata* from northeastern Europe, that this species shows a world-wide distribution in the Middle Albian to Cenomanian, extending to Japan. As nobody described *P. planulata* from Japan, he may have considered that *P. subcorbarica* Matsumoto, 1954 is identical with *P. planulata* (J. de C. Sowerby, 1827), which now should be called *P. mayoriana* (d'Orbigny, 1841).

Wright and Kennedy (1984) described *P. mayoriana* primarily on the material from the uppermost Albian to Cenomanian of northwestern Europe, showing some examples of variation. *P. subcorbarica* is similar to *P. mayoriana* in some respects, but is distinguished by more compressed whorl (B/H smaller than 1.02—0.75 of the latter) and less flexuous ribs which do not show a noticeable projection at mid-flank.

According to Marcinowski the microconchs of that species have somewhat coarser ribs, as he clearly illustrated (Marcinowski, 1980, pl. 6, figs. 8—11). In our case the adult microconch is as finely ribbed as the phragmocone of both macro- and microconchs. Marcinowski's example of microconch seems to have been regarded as one case by Wright and Kennedy (1984, p. 57, pl. 4, figs. 6 and 7), who showed two examples of microconchs in *P. mayoriana,* one with less dense and coarser ribs in the late stage and the other with dense and fine ribs persisting. In the Albian of Hokkaido, I have not yet seen any variety with coarser ribbing.

In the recent papers (e.g. Kennedy 1971, Renz 1972, Henderson 1973, Copper 1978, 1982, Immel 1979, Scholz 1979, Wright 1979, Marcinowski 1980, Szász 1983, Wright & Kennedy 1981, 1984), in which species of *Puzosia* are described, I find no illustrated example which shows clearly the characters of adult macroconchs. To get an adequate concept of a species these are necessary together with those of adult microconchs as well as those of immature stages.

A huge specimen kept at the Geological Survey of India Calcutta, illustrated long ago by Stoliczka (1865, pl. 68) was described under *Ammonites planulatus* Sowerby. It is recorded to

have come from the Trichinopoly Group of Anapaudy and therefore must be somewhere between the Lower Turonian and Coniacian and it may not be the named species. At any rate, it does represent a full-grown macroconch. By courtesy of Mr. Sastry, Chief Palaeontologist at that time, I studied this specimen in 1964. It is about 83 cm in diameter near the end of the body-chamber which is marked by a broad constriction, concave on side and projected on venter. The main part of the body-chamber is nearly smooth without such radial bulges as seen on the macroconch body-chamber of *P. subcorbarica*. At about 90° behind the apertural end in the late part of the body-chamber of Stoliczka's specimen the whorl is somewhat, but not much, broadened, as measured below:

Position	D	U	H	B	B/H
E–90°	690 (1)	255 (.33)	260 (.38)	25.5 (.37)	0.98
E–180°	580 (1)	185 (.32)	215 (.37)	180 (.31)	0.83

A fairly large specimen, from the Middle Albian *dentatus* Zone of Izere, France, illustrated by Jacob (1908, pl. 16, fig. 2) under *Puzosia mayoriana* (d'Orbigny) probably represents a well preserved macroconch. It has rectiradiate major ribs at wide intervals on the body-chamber and the ribs have nodes at the ventrolateral shoulder. I once referred it to *Anapuzosia,* but this was probably wrong because its phragmocone has fine ribs on the outer part of the whorl as in typical *Puzosia* and is different from the more strongly ribbed phragmocone of *P. buenaventura* Anderson, the type species of *Anapuzosia*. Jacob mentioned that *Puzosia planulata* from the Basses-Alpes is as large as the above mentioned large specimen of his *P. mayoriana* but does not show such a strong ornamentation. Should *P. planulata* be truly identical with *P. mayoriana,* then the specimen of Jacob with distant strong ribs on the body-chamber would be a macroconch of another species of a different genus (see p. 27). Anyhow, this macroconch is evidently different from the macroconch of *P. subcorbarica*.

I expect that someone would give a sufficient description of the full-grown macroconch of *P. mayoriana* = *P. planulata*. Until this is accomplished, I would not regard that species as being well defined and cannot conclude that *P. subcorbarica* is identical with *P. mayoriana*. Even if the body-chamber of the adult macroconch of *P. mayoriana* were similar to that of *P. subcorbarica,* the two taxa are distinguished by the above mentioned differences at least subspecifically.

Matsumotoceras donlisteri van Hoepen, 1968 (for 1965) (p. 157, pl. 1, fig. 1), based on a single large specimen (D = 603 mm) from the Upper Turonian (or possibly Coniacian ?) of South Africa, shows on its last whorl broad, wave like major ribs which fade away on the outer part. In this respect, it is similar to the macroconch of *P. subcorbarica*. It has fine ribs on the outer third of inner whorls. Its distinction from *P. subcorbarica* is in its oval section with more convex flanks of the outer whorl, narrower umbilicus (U/D = 0.26) and less pronounced projection of the fine ribs. Hoepen reported the absence of constrictions, but this is doubtful and the inner whorls seem to be faintly constricted as in *Puzosia manasoaensis* Collignon, 1961.

Occurrence:—Not rare in the Albian mudstone of the Ikushumbets (Mikasa), Yubari and Oyubari areas, central Hokkaido, but the precise stratigraphic range of this species should be investigated further.

Puzosia aff. *provincialis* (Parona et Bonarelli)

(By T. Matsumoto and T. Takahashi)

Figure 3

Compare:—

1897. *Desmoceras provinciale* Parona et Bonarelli, p. 81, pl. 11, fig. 4.
1968. *Puzosia provincialis* (Parona et Bonarelli); Wiedmann and Dieni, p. 118, pl. 10, figs. 1, 8; pl. 11, figs. 1, 2, 4, 5, 7, 12; text-fig. 74.

Material:—GK. H8093, obtained by T. Takahashi (TTC. 570711) from the shale of the Yuno-sawa, Ikushumbets and donated to Kyushu University through T. M.

Descriptive remarks:—This specimen is not contained in a calcareous nodule but embedded in mudstone. Therefore it is secondarily deformed and its septate inner whorls are badly squashed for the most part.

The measurements in the deformed state at the position 180° adorally from the last septum are as follows:

D	U	H	B	B/H
81.0 (1)	23.2 (.29)	33.0 (.41)	*c.* 20 (.25)	*c.* 0.6

The body-chamber is about 240° and the basal projection of the lappet (mid-lateral ear) is preserved at its apertural end. There are five constrictions on the body-chamber, of which the last one is

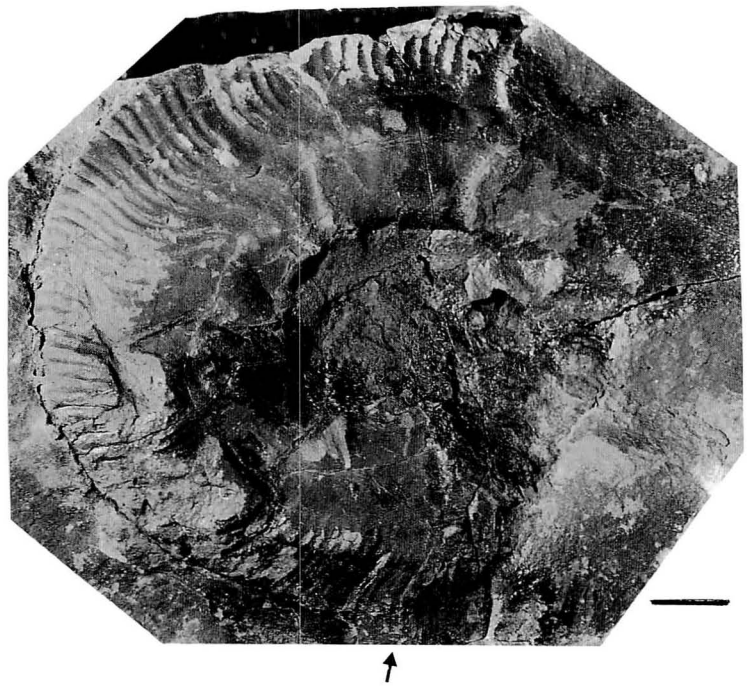


Figure 3. *Puzosia* aff. *provincialis* (Parona et Bonarelli).
Microconch in mudstone, from the Yuno-sawa, Ikushumbets Valley (Coll. T. Takahashi), TTC. 570711 = GK.H8093, showing falcoid constrictions and a lappet; bar = 10 mm.

immediately behind the aperture and rather sharply projected at the base of the lappet and the last second is similarly falcate; others are falcoid with less acute projection. In front of the constriction near the last septum there is a distinct trace of a resorbed lappet (parabole).

The ribs on the outer half of the whorl are numerous, dense, rather fine and projected. Some of them may extend, though with much weakening, to the inner part of the flank in the last quarter of the body-chamber, showing a falcate bending like that of the last constriction.

With respect to the mode of ribbing and falcoid to falcate constrictions, this specimen is similar to the illustrated specimens of *Puzosia provincialis* (Parona et Bonarelli) (1897, pl. 81, pl. 11, fig. 4) (see Wiedmann & Dieni, 1968, p. 118, pl. 10, figs. 1, 8; pl. 11, figs. 1, 2, 4, 5, 7, 12; text-fig. 74) from the Albian of Europe, but that species has broader whorls, with B/H = 1.0 on an average, and the falcoid constriction begins to occur at an early growth stage. The specimen from Hokkaido seems to have originally compressed whorls.

Mr. Kenji Kitamura, who is studying the Cretaceous strata in the Akaishi Mountains, central Japan, has kindly showed us a less deformed specimen, which resembles quite well the specimen from Hokkaido, although its ribs are apparently weak probably because of the internal mould of a younger shell. Its whorl is distinctly more compressed (B/H = about 0.7) than that of *P. provincialis*. It shows the suture of *Puzosia* pattern. If these two specimens from Hokkaido and Akaishi are of identical species, they represent probably a new species allied to but distinct from *P. provincialis*. We should look for more specimens from the two and other areas. A macroconch of this species has not yet been confirmed.

Occurrence:—From the shale exposed in a small stream called Yuno-sawa, a branch of the River Ikushumbets. The strata exposed along the Yuno-sawa are Upper Albian, because *Mortoniceras* (*s. l.*) sp. and *M.* (*Cantabrigites*) *imaii* (Yabe) occur there.

Puzosia elegans sp. nov.

(By T. Matsumoto)

Figure 4

1975. *Puzosia* aff. *intermedia orientale* (*sic*) Matsumoto; Matsumoto and Kawano, pl. 1, fig. 2,

Material:—Holotype, NSM. Pl-6345, collected from loc. Ik 1038b of Matsumoto, Ikushumbets (Mikasa) area, by T. Muramoto who donated it to the Museum. Paratype, a smaller specimen from the same locality which was illustrated under *Puzosia* aff. *intermedia orientalis*.

Diagnosis:—Shell discoidal, fairly involute and fairly narrowly umbilicate for the genus. Whorl much higher than broad and broadest at about one third of whorl-height from the umbilical margin. Flanks nearly flat or slightly convex, gradually convergent to the narrowly arched venter and abruptly bent to the low but vertical umbilical wall, forming subangular shoulder.

Narrow and weak constrictions or flares frequent on the phragmocone, slightly prorsiradiate and nearly subradial or very gently sigmoidal. Numerous, fine, short and moderately projected subcostae on the outer part (i.e. outermost flank and venter) of the phragmocone may change to somewhat coarser but weak and short riblets on that of the earlier part of the body-chamber. On the outer whorl, i.e. last part of phragmocone and body-chamber, periodic flares are discernible only on the inner flank and become blunt (lowered and broaden) on the body-chamber.

Suture of typical *Puzosia* type, showing asymmetrically tripartite and expanded L and strongly descending auxiliaries.

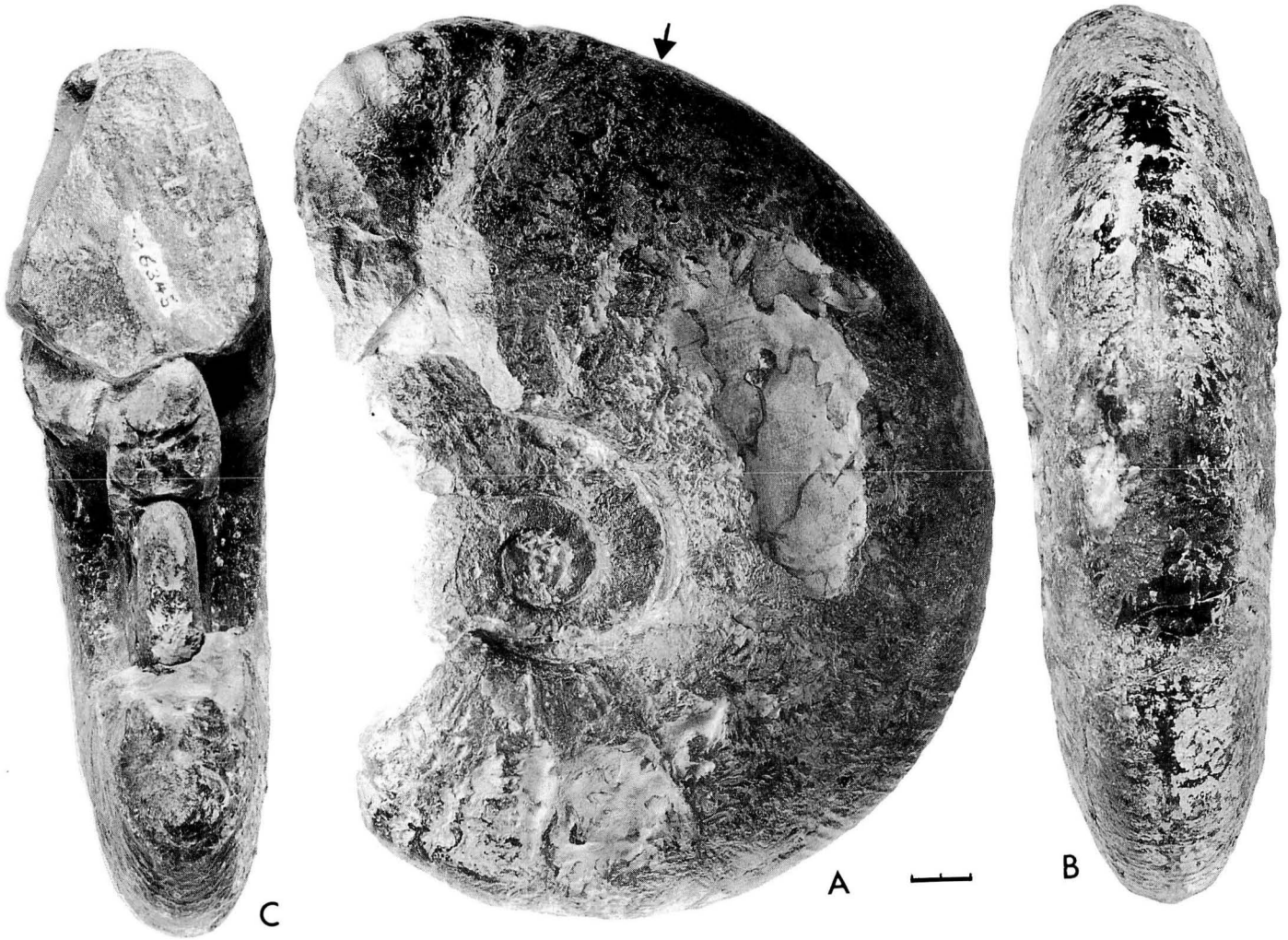


Figure 4. *Puzosia elegans* Matsumoto, sp. nov. Photos by S. Sato.
A—C: holotype, NSM. P1—6345 from loc. Ik 1038b, Zone of *Euomphaloceras septemseriatum,* Ikushumbets Valley (T. Muramoto Coll.); scale bar = 20 mm.

Observations:—The holotype exhibits the distinct characters which enable us to establish a new species, although its body-chamber is incomplete. In view of its large size (D = 288 mm at LS) and weakening of ornaments with appearance of blunt umbilical bullae on the body-chamber, this specimen is interpreted as an example of adult macroconch, whereas a microconch with complete apertural margin has not yet been confirmed in this species.

The smaller paratype in Kawano's Collection is well preserved and matches well the younger part of the holotype, but the extent of variation in this species should be worked out in the future.

Dimensions:—

Specimen	D	U	H	B	B/H	H/h	Inv
(1)	300.0	81.0 (.27)	131.0 (.44)	*c.* 84 (.28)	0.64	1.49	0.53
(2)	*c.* 210	*c.* 58 (.28)	88.0 (.42)	61.0 (.29)	0.69	—	—
For comparison							
(3)	120.0	50.5 (.42)	38.5 (.32)	23.4 (.195)	0.61	1.24	0.46
(4)	115.0	27.0 (.23)	55.0 (.48)	32.0 (.28)	0.58	1.53	—

(1): holotype, at the preserved end, (2): −180° from (1), (3): lectotype of *P. compressa,* (4) holotype of *Austiniceras beantalyense* (after Collignon, 1961).

Comparison and discussion:—With respect to the flat-sided and compressed whorl with weak and fine costae on the ventral part, this species is similar to *Puzosia compressa* Kossmat, 1898, whose **lectotype** here designated is *Ammonites durga* Stoliczka, 1865, p. 143, pl. 71, fig. 7, 7a, 7b (non Forbes, 1846), from Odium, from the Upper Albian of South India. The distinction between the two species is clear in that *P. compressa* has much wider umbilicus, somewhat more compressed whorl with flatter flanks and well marked (i.e. deeper and wider) constrictions. The specimens of the same species described by Boule *et al.* (1906, p. 190, pl. 4, fig. 3; pl. 4, figs. 1, 2; text-figs. 9, 10) and Collignon (1961, p. 28, pl. 2, fig. 1), from the Lower Cenomanian of Madagascar, show the same distinction.

This species is somewhat similar to certain species of *Austiniceras,* e.g. *A. beantalyense* Collignon (1961, p. 44, pl. 13, fig. 1) from the Coniacian of Madagascar and such a form of *A.* (?) *transsylvanicum* (Simionescu, 1944) as figured by Szász (1983, pl. 6, fig. 1) from the Cenomanian of Rumania, in fairly involute and compressed shell-form and narrow but frequent flares in a late stage, but the ventral ribs of this species are much shorter and weaker; consequently the rest main part of the flank looks nearly smooth. Therefore I should assign this species to *Puzosia* rather than to *Austiniceras.*

Occurrence:—The holotype and paratype occurred in the siltstone exposed at loc. Ik 1038 on the right side of the main stream of the River Ikushumbets. This mudstone belongs to the uppermost part of Member IIc and overlain by the green-sandstone at the base of Member IId in the sequence of the Mikasa Formation (see Matsumoto, 1965, fig. 2 and fig. 4 for the route map and stratigraphic section; Matsumoto and Kawano, 1975 for a sketch of the exposure Ik 1038). The holotype was obtained by T. Muramoto from a nodule taken at Ik 1038b, about 3 meters below the top of Member IIc and the paratype by T. Kawano from a nodule about 7 m below the same top. Anyhow, the main part, about 15 m in thickness, of the siltstone is prolific and characterized by ammonite species *Euomphaloceras* (*Kanabiceras*) *septemseriatum* (Cragin), *Pseudocalycoceras dentonense* (Moreman), *Tarrantoceras* (*Sumitomoceras*) *faustum* (Matsumoto

et Muramoto), *Sciponoceras kossmati* (Nowak), *Allocrioceras* sp. etc. It is the type section of the Zone of *Euomphaloceras septemseriatum* in the Upper Cenomanian of Japan.

Puzosia orientalis Matsumoto

(By T. Matsumoto and Y. Kawashita)

Figures 5, 6 and 25A

1898 *Puzosia gaudama* Forbes; Kossmat, p. 115, pl. 16, fig. 2.
1954b. *Puzosia orientale* (*sic*) Matsumoto, p. 74, pl. 13, figs. 1—2.
1954b. *Puzosia orientale kossmati* (*sic*) Matsumoto, p. 75.
1959b. *Puzosia intermedia orientalis* Matsumoto; Matsumoto, p. 16, pl. 4, fig. 1.

Holotype:—GK. H1225 from loc. Y420c, member IIn of the Middle Yezo Group, the Hinata-zawa of the Shiyubari Valley (i.e. upper reaches of the River Yubari, north of the Oyubari area), central Hokkaido (T. Matsumoto coll. 1939), reillustrated in this paper (Fig. 5).

Material:—There are more examples of this species in the subsequent collections from Hokkaido, of which the specimen collected by Ms. Kikuye Kato from loc. Y5162 (of T. Matsumoto) on the right side of the stream called Taki-no-sawa [=Penke-mo-yuparo] of the Oyubari area is illustrated (Fig. 6).

Diagnosis:—Shell moderately involute with medium to somewhat narrower umbilicus. Whorl fairly higher than broad, with B/H ranging from 0.72 to 0.80 among individuals or at different growth-stages; flanks slightly or gently convex, passing to more or less narrowly arched venter; umbilical wall steep passing to flank with subrounded shoulder.

Periodic constrictions narrow and shallow, 4 to 6 to a whorl, slightly prorsiradiate or gently concave on the inner flank and curved more or less forward on the outer flank, crossing the venter with a convex curve: the associated flares also weak. Numerous, fine and dense ribs on the outer part in parallel to the constrictions, narrow and sharp-headed on the shell surface but less so and crowded on the internal mould.

At the late septate stage of macroconch weak major ribs appear at wide intervals on the inner flank and change to blunt radial elevations on still later part (i.e. last part of phragmocone and early part of body-chamber), whereas the minor outer ribs weaken and finally disappear. No significant change in shell-form in the adult macroconch, but for slightly more convex flanks which may result in suboval whorl-section. Complete microconch not yet known.

Dimensions:—

Specimen	D	U	H	B	B/H	H/h	Inv.
(1)	127.0	44.5 (.35)	49.5 (.39)	38.0 (.30)	.77	—	—
(2)	406.0	121.0 (.30)	167.0 (.41)	123.0 (.30)	.74	1.41	.52
(3)	307.0	94.0 (.30)	122.0 (.40)	96.0 (.31)	.78	1.39	—
(4)	175.0	49.0 (.28)	76.0 (.43)	61.0 (.35)	.80	—	—
(5)	80.0	26.0 (.32)	32.0 (.40)	23.0 (.29)	.72	—	—

(1): holotype (middle stage), (2): K. Kato's specimen at LS, (3): ditto, —120°, (4): UC. 36438 (after Matsumoto, 1959b), (5): Kossmat, 1898, pl. 16, fig. 2 (after Kossmat, 1898).

Observations:—The holotype was a large fossil shell which was broken into several pieces, two parts of which were illustrated (Matsumoto, 1954b, pl. 13, fig. 1, 2). This is now supplemented

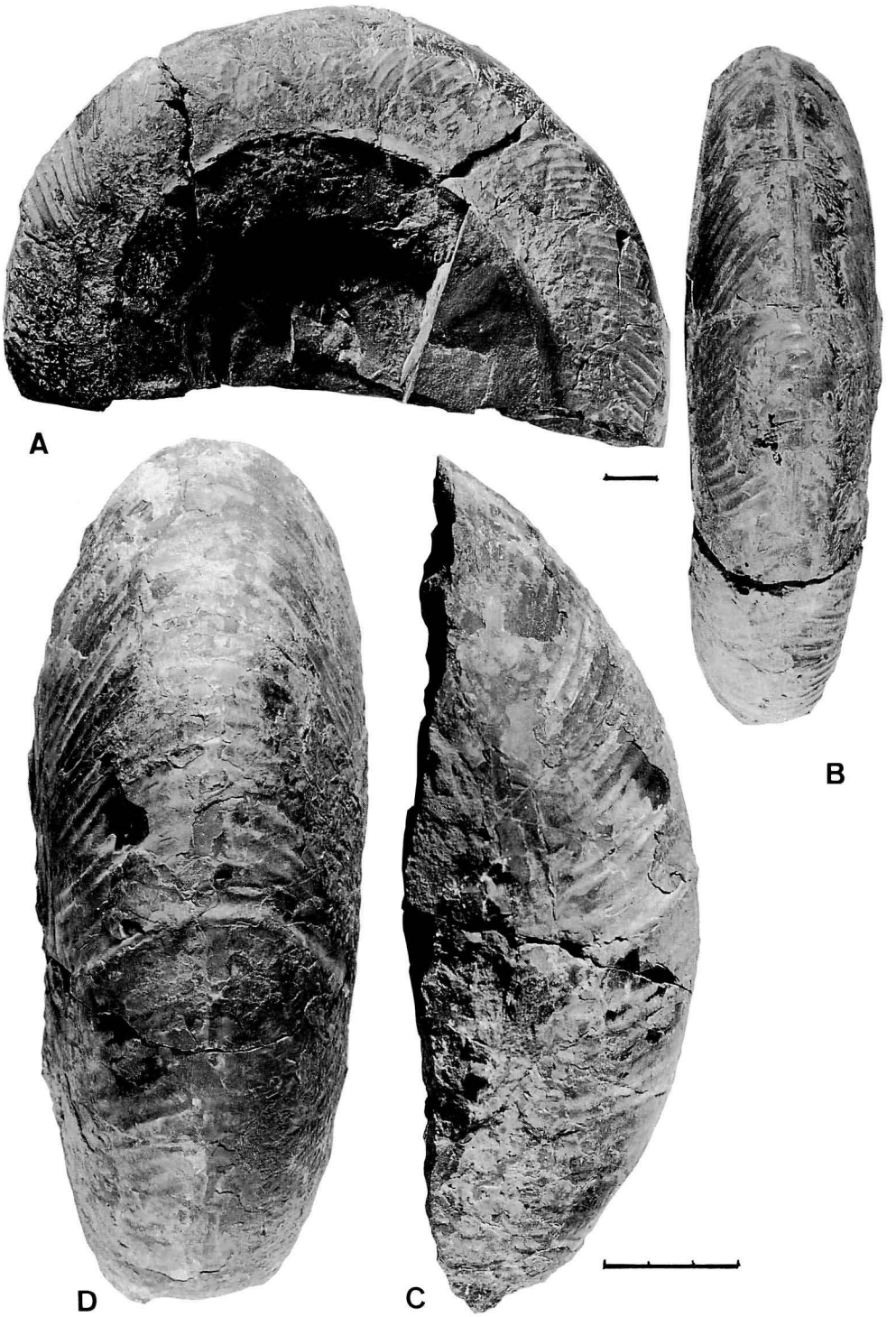


Figure 5. *Puzosia orientalis* Matsumoto.
A—D: holotype, GK. H1225 from loc. Y420c, the Shiyubari Valley (Coll. T. Matsumoto). A—B: inner whorl; bar = 10 mm. C: next outer whorl, still septate; bar = 30 mm.

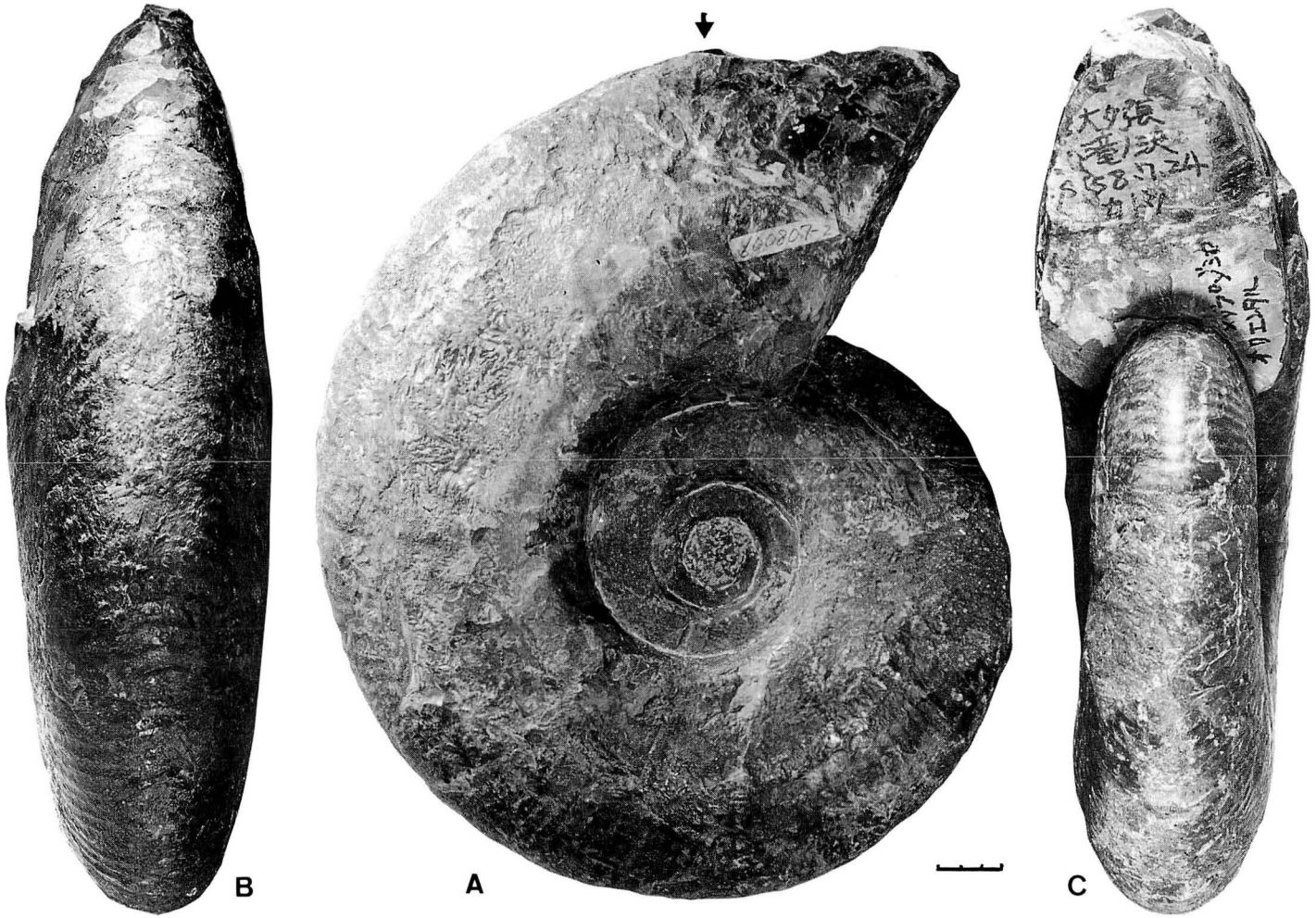


Figure 6. *Puzosia orientalis* Matsumoto.

A—C: macroconch with a posterior fraction of distorted body-chamber at the preserved end, K. Kato Coll. 580724, from the Zone of *Mytiloides mytiloides*, Taki-no-sawa, Oyubari area; bar = 30 mm. The last part is secondarily deformed. See Fig. 25A for the whorl-section at LS.

by a well preserved large specimen obtained by K. Kato from the same unit in the generally same Shiyubari-Oyubari area (if not at the type locality). It consists mainly of the septate whorls and the posterior portion (about 30°) of the body-chamber in its preserved last part. The latter is secondarily deformed, whereas the phragmocone is undeformed. The umbilical seam of the lost main part of the body-chamber is traced for about 210°. On the assumption that little change occurred in the umbilical ratio U/D, the entire shell diameter would exceed 660 mm. The weakening of the outer ribs and development of blunt radial elevations on inner flank at the last stage of the phragmocone suggest the nearly smooth body-chamber with blunt radial undulations as in the case of *P. subcorbarica*.

Examples of the microconch of this species are insufficient in the available material from Hokkaido. An example from the lower part of the Trichinopoly Group in South India, which was described under *P. gaudama* by Kossmat (1898, pl. 16, fig. 2) may be a microconch but is incomplete in that its very apertural margin is not preserved.

Comparison and discussion:—I now agree with Wright (1979, p. 309) in regarding *P. intermedia* Kossmat [=*P. gaudama* var. *intermedia* Kossmat (1898, P. 116, pl. 17, fig. 3)] as a distinct species which is independent of *P. orientalis* or *P. curvatisulcata* Chatwin et Withers, 1909.

In my present view, however, *P. orientalis* is also distinct from *P. curvatisulcata* from the Upper Turonian Chalk Rock of England, as redefined by Wright (1973, p. 308). The lectotype of that species (BM. C12229a, Chatwin and Withers, 1909, pl. 2, figs. 1—2) shows the subovoid whorl-section which is broadest at about one third of the whorl-height, whereas *P. orientalis* has the subelliptical whorl-section which is broadest at about the mid-height.

BM. C79501, which I once studied and is now illustrated by Wright (1979, pl. 4, fig. 4) under *P. curvatisulcata,* is more similar to the inner whorl of *P. orientalis* with respect to the shell-form and also the ribbing (fine ribs only on the outer part of the whorl). It might represent a survivor of *P. orientalis* which occurred in the Upper Turonian of England. Wright seems to interpret that many of the fine ribs of *P. curvatisulcata* originally extended inward towards the umbilical margin as those of *P. gaudemarisi* Roman et Mazeran (1913, pl. 2, figs. 1, 2), which he regarded as a synonym of *P. curvatisulcata*. In the well preserved specimens of *P. orientalis* fine ribs are developed only on the outer part of the whorl. The feature may be modified by the mode of preservation and the Chalk Rock specimens are often internal moulds without or with only fractions of shelly material. Therefore it is difficult to give a definite conclusion on the ribbing of *P. culvatisulcata*.

The degree of forward bending of the ribs and constrictions on the outer part of the flanks seems to show some extent of variation between individuals and with growth-stages. Therefore, I hesitate to hold the subspecies *P. orientalis kossmati* Matsumoto, 1954, which was established on the specimen illustrated by Kossmat (1898, pl. 16, fig. 2). Anyhow, this point should be examined on more specimens from both northern Pacific and Indo-Mediterranean regions.

GK. H1223, from loc. Y137 of the Shiyubari Valley, which I described under *Puzosia orientale intermedia* Kossmat (*sic*) in my previous paper (Matsumoto, 1954b, p. 76, pl. 12, figs. 2, 3) was my mis-identification. In this specimen there are numerous long ribs with intercalated or branched shorter ones, the flares which were at first associated with constrictions become frequent and turn to be major ribs in the late stage of the phragmocone, and the flares or constrictions and longer ribs are gently flexuous on the main part of the flank but all the ribs and constrictions

(or flares) are projected on the outer part. The whorl is compressed, with narrowly arched venter, rather flat flanks, subangular umbilical shoulder and low but vertical umbilical wall. On the ground of above characters I should now regard this specimen as a phragmocone of *Austiniceras* cf. *austeni* (Sharpe).

The small specimen described under *Puzosia* (*Austiniceras*) *intermedia orientalis* Matsumoto by Cooper (1978, p. 75, text-fig. 13) from Angola may be an immature *Austiniceras* and not related to *P. orientalis* redefined in this paper.

P. orientalis is somewhat similar to *P. subcorbarica* in the numerous, fine, and narrow ribs on the outer part of the whorl, but the former has gently convex flanks and subrounded umbilical shoulders, whereas the latter has rather flat flanks, subangular shoulder and low but vertical umbilical wall. The forward curve of the numerous ribs on the outer part of the whorl is on the average more remarkable in the former than that in the latter, but the variations of this character in the two species may overlap with each other.

Occurrence:—The holotype and another typical specimen illustrated in this paper occurred in the Lower Turonian Zone of *Mytiloides mytilodies*. Specimens or casts probably referable to this species have been obtained or observed not rarely in the Lower to Middle Turonian of several areas (Ashibetsu, Obira, etc.) in Hokkaido. The occurrences of this species in the oversea regions should be reexamined.

Puzosia cf. *manasoaensis* Collignon

(By T. Matsumoto and Y. Kera)

Figure 7

Compare:—

1961. *Puzosia manasoaensis* Collignon, p. 34, pl. 5, fig. 2.

Material:—No. 355 in Y. Kera's Coll., from the Ohmaki-zawa, Oyubari area.

Description:—A single large specimen lacking in the ventral part of the last half whorl of phragmocone and major part of body-chamber. Its dimensions at the end of the reconstructed phragmocone (1), compared with those of the holotype (2) (Collignon, 1961, p. 34, pl. 5, fig. 2), are as follows:

	D	U	H	B	B/H	R/r
(1)	310	102 (.33)	125 (.40)	71 (.23)	0.57*	1.46
(2)	106	32 (.30)	44 (.41)	26 (.25)	0.59	1.45

The ratio B/H of (1) in the above table (*) is based on the measurable undestroyed late part of the phragmocone and assumed to be kept generally unaltered. The umbilical seam of the last main part of the body-chamber is traced for at least 180°. Therefore the entire shell diameter must have been still larger, probably exceeding 420 mm.

This specimen, though incomplete, shows clearly a discoidal and flat-sided shell, consisting of compressed, high whorls with nearly flat and subparallel flanks, encircling the umbilicus of moderate width with low and steeply inclined wall and subrounded shoulder. (The umbilical shoulder is abruptly rounded but not angular, except for the secondarily deformed part). In spite of the compressed whorl, the venter is rather evenly rounded.

Constrictions are rather shallow and of moderate frequency (6 to a whorl) upto the middle

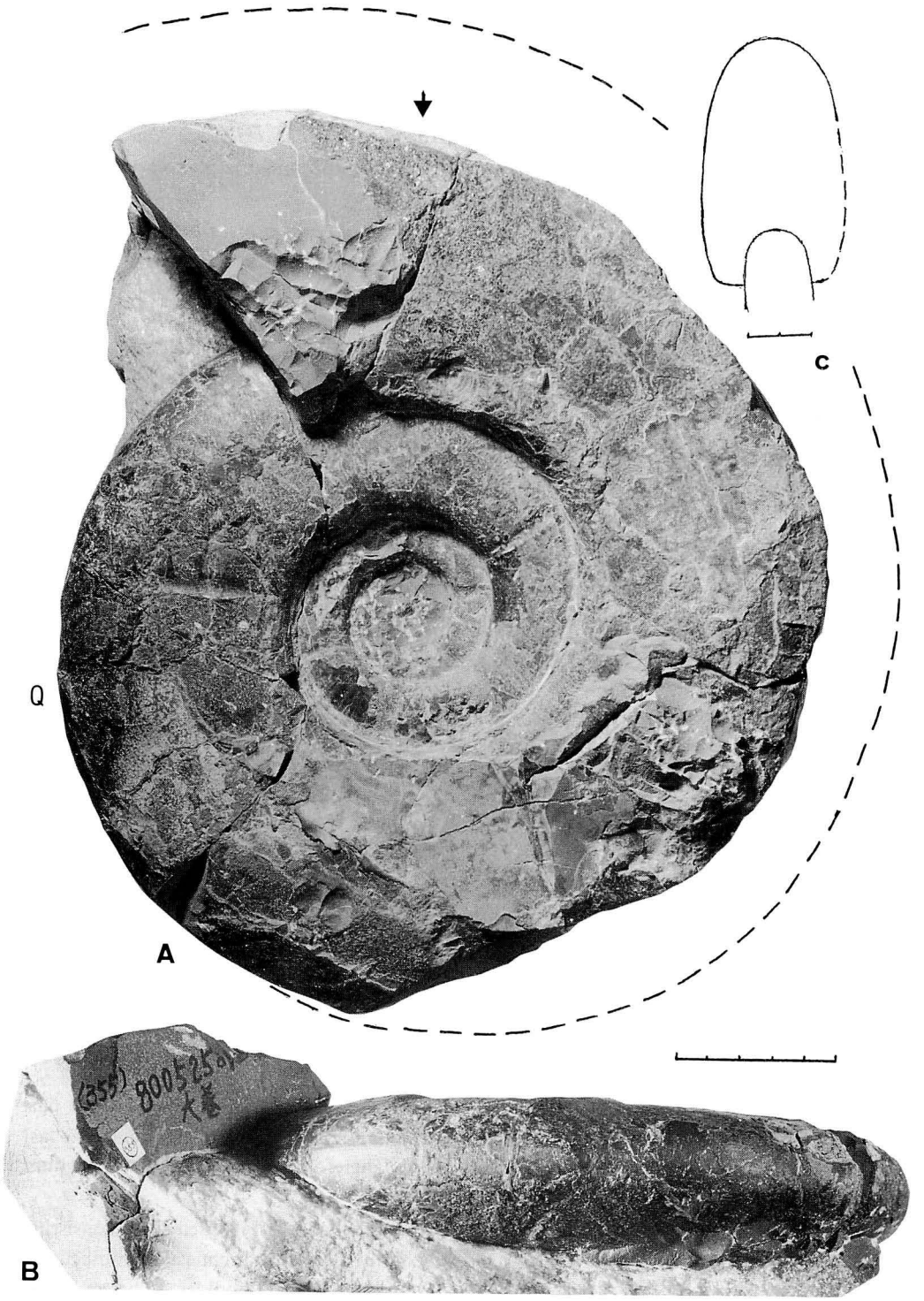


Figure 7. *Puzosia* cf. *manasoaensis* Collignon.
A—B: Y. Kera's Coll. no. 355 from the Ohmaki-zawa, Oyubari area, scale bar = 50 mm; C: diagrammatic whorl-section of the same specimen at Q in fig. 7A; bar = 20 mm.

growth-stage, but not distinct (obscured or absent) in the last 240° of the phragmocone where the shell is somewhat destroyed. In the state that the outer shell surface is unpreserved for the exposed main part of this specimen, the shell looks nearly smooth. Numerous, fine and weak ribs do exist on the outer flank and venter, showing a considerable projection (i.e. forward bent curve), where the outer shell surface is preserved. They are so weak that they are scarcely impressed on the internal mould. At one portion where outer shell surface is preserved on the inner whorl, several radial ribs are faintly discernible on the inner flank. In the rest main part, the inner flank looks entirely smooth, even where the shell layer (perhaps inner one) is preserved.

The suture-lines exposed partly here and there are finely and deeply incised, following the typical pattern of *Puzosia*.

Comparison:—This single specimen, though incomplete, represents a species which has not yet been reported from Hokkaido. On the ground of the characteristic features described above, I refer it provisionally to *P. manasoaensis* Collignon (1961, p. 34, pl. 5, fig. 2), from the Coniacian of Madagascar, regarding the marked difference in size as dimorphism. The holotype of this species is nearly wholly septate with the beginning of the body-chamber at its last portion. The specimen from Hokkaido is about three times as large as that holotype.

A question remains as to the ribbing. If many of the ribs on the outer part of the whorl extended on to the inner flank, this ammonite could be referred to *Mesopuzosia*. As to the holotype, this point is not clear either, for it is an internal mould for the most part and the fine and dense ribs are shown only where shell surface is preserved. For the time being, I should follow Collignon to refer it to *Puzosia* and call the described specimen from Hokkaido *Puzosia* cf. *manasoaensis* Collignon.

P. compressa Kossmat, 1898, mentioned in the description of *P. elegans* sp. nov., is also compressed and flat-sided, but is more evolute, having wider umbilicus, smaller ratio of whorl expansion and more distinctly marked constrictions.

The holotype, by monotypy, of *Puzosia rauffi* Zimmermann (1912, p. 537, pl. 25; text-fig. 4), from the *labiatus*-Pläner of Westfalia (northwestern Germany), is as large as or somewhat larger than the described specimen from Hokkaido, for it is 485 mm in diameter at the preserved end (about 210°) of the body-chamber. In lateral view they are similar in having flat flanks, moderately wide umbilicus (U/D = 0.33), smooth-looking internal mould of the outer whorl and weak constrictions on the inner whorl. Zimmermann considered that weak ribs may have existed on the ventral part but have been obscured owing to some weathering. The distinction may be somewhat broader whorl of the German species, although there is a doubt as follows. Zimmermann recorded H = 180 and B = 120 mm; accordingly B/H = 0.67 on the outer whorl and h = 105 and b = 83, accordingly b/h = 0.79 on the next inner whorl. This change of B/H with growth of one whorl seems to be too great, if not impossible, for a species of *Puzosia*. My estimation from the figures of his pl. 25 gives H = 180, B = 140 and B/H = 0.78, a reasonable amount. Although I have not examined the original specimen of Zimmermann, I guess that there may be a misprint in his measurement.

In various features this species looks very similar to *Hauericeras* (*Gardeniceras*) *angustum* Yabe, although the latter has a septicarinate keel along the siphonal line in late growth-stages. This gives us a working hypothesis that the genus *Hauericeras* de Grossouvre may have been derived from this kind of *Puzosia*. Dimorphic pair is known in *H.* (*G.*) *angustum*.

Occurrence:—Y. Kera obtained this specimen from a nodule as a boulder of the Ohmaki-zawa at a point 750 m linearly eastward from the conference with the River Yubari, Oyubari area on

May 25, 1980. In the neighbourhood of this place, strata of Coniacian age belonging to the Zone of *Inoceramus mihoensis* and Zone of *I. uwajimensis* are exposed (see a geological map in Matsumoto and Haraguchi, 1978, fig. 1). In fact an immature inoceramid specimen, *I.* cf. *uwajimensis* Yehara, is associated with this ammonite.

According to Collignon (1961), the holotype of *P. manasoaensis* occurred in the Zone of *Barroisiceras onilahyense* of Coniacian age.

Genus *Mesopuzosia* Matsumoto, 1954

Mesopuzosia pacifica Matsumoto

(By T. Matsumoto, T. Takahashi, Y. Kawashita and Y. Kera)

Figures 8—11; 25B—D

1954b. *Mesopuzosia pacifica* Matsumoto, p. 82, pl. 14, fig. 1; pl. 15, figs. 1—2; pl. 16, figs. 1—3; text-fig. 2.
1959b. *Mesopuzosia pacifica* Matsumoto; Matsumoto, p. 18, pl. 6, fig. 2, text-fig. 6.
1972. *Mesopuzosia pacifica* Matsumoto; Matsumoto *et al.*, p. 390, text-fig. 9.

Holotype:—GK. H1257 (Matsumoto, 1954b, pl. 15, fig. 1), from loc. Y216pl, Turonian Saku

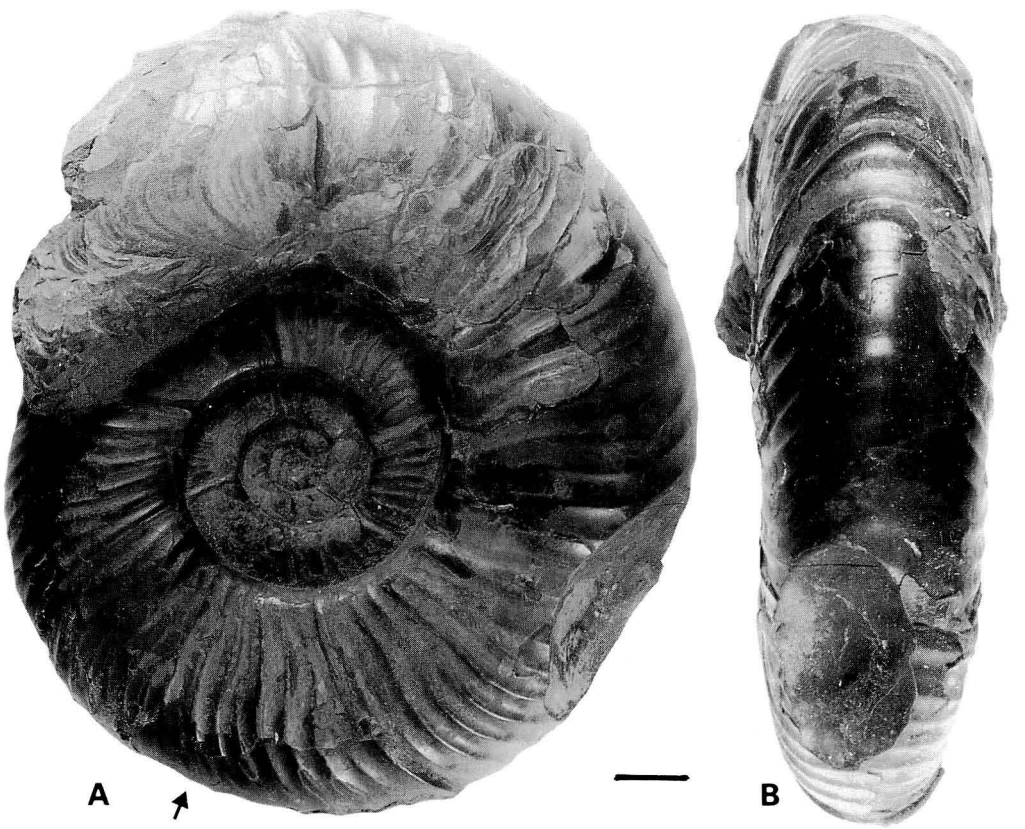


Figure 8. *Mesopuzosia pacifica* Matsumoto.
A—D: microconch with the apertural margin preserved, TTC. 530806 from

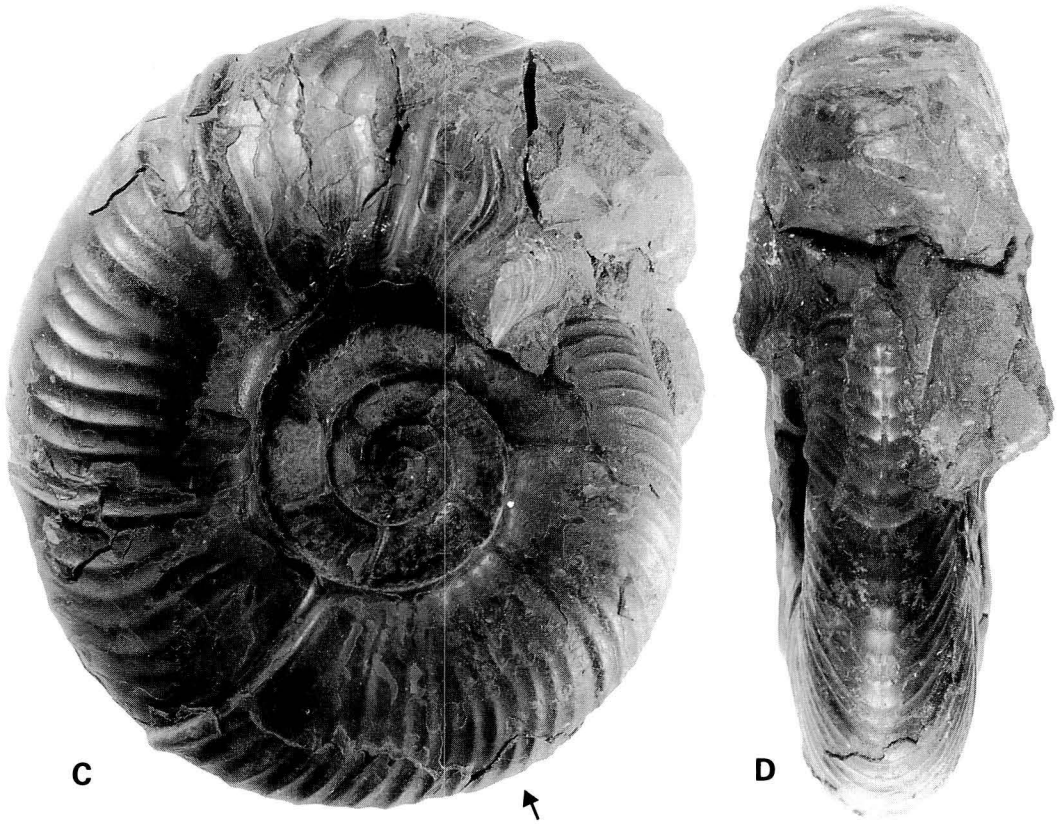
Formation of the Shiyubari-Oyubari area, central Hokkaido (T. M. Coll.).

Material:—Numerous specimens listed by Matsumoto (1954, p. 82) and subsequent collections, of which TTC. 530806 (Fig. 8), obtained by T. Takahashi from the Hakkin-zawa, and MCM. A111-2 (Fig. 9), collected by A. Tomita from the Hakkin-zawa and donated to MCM. are fine examples of microconchs, whereas YKC. 500629 (Fig. 10) obtained by Y. Kawashita from a small stream in the lower reaches of the Kaneobets and now set at the official room of the Superintendent of Education in the Public Hall of Mikasa City and another in Y. Kera's Coll. no. 475 (Fig. 11) from the Panke-moyuparo are examples of macroconchs.

Diagnosis:—A species of *Mesopuzosia* characterized by moderate involution, fairly wide umbilicus, somewhat high whorl, which is subelliptical in section with gently convex flanks and moderately rounded venter, well marked constrictions and associated flares of moderate frequency and ribs of moderate intensity and density, which are more or less sigmoid on the flank and moderately projected on the venter.

Microconch of moderate size, with moderate rate of whorl expansion. Some ribs distinctly sigmoid.

Macroconch very large, with higher rate of whorl expansion. Shell in the late septate part high whorled, more (but not much) narrowly umbilicate, with gently sigmoid, dense ribs which



the Hakkin-zawa, Oyubari area (Coll. T. Takahashi); scale bar = 10 mm.

weaken and finally disappear on the body-chamber, where blunt radial elevations appear around the umbilicus.

Dimensions:—

Specimen	D	U	H	B	B/H	H/h	R/r
Holotype	101.5 (1)	34.5 (.34)	39.5 (.39)	33.5 (.33)	.85	1.44	—
TTC. 530806 (1)	111.0 (1)	40.5 (.36)	39.5 (.36)	32.5 (.29)	.82	—	—
TTC. 530806 (2)	101.6 (1)	37.0 (.36)	38.0 (.37)	32.0 (.30)	.84	1.42	1.48
MM. A111-2	127.0 (1)	42.0 (.33)	47.0 (.37)	41.0 (.32)	.87	1.24	—
YKC. 500629	315.0 (1)	83.0 (.26)	144.0 (.46)	*c.* 88 (.28)	.61	1.50	1.56
Kera 475 (3)	315.0 (1)	91.0 (.29)	140.0 (.44)	*c.* 90 (.29)	.64	1.66	1.62
Kera 475 (4)	264.0 (1)	74.5 (.28)	112.0 (.42)	*c.* 78 (.29)	.69	1.43	1.53

(1) behind the last flare; (2) —60° from 1, (3) behind the preserved last flare (late part of phragmocone); (4) —90° from (3), See also Matsumoto, 1954, p. 82-83.

Description of microconch:—An example of this species with completely preserved apertural

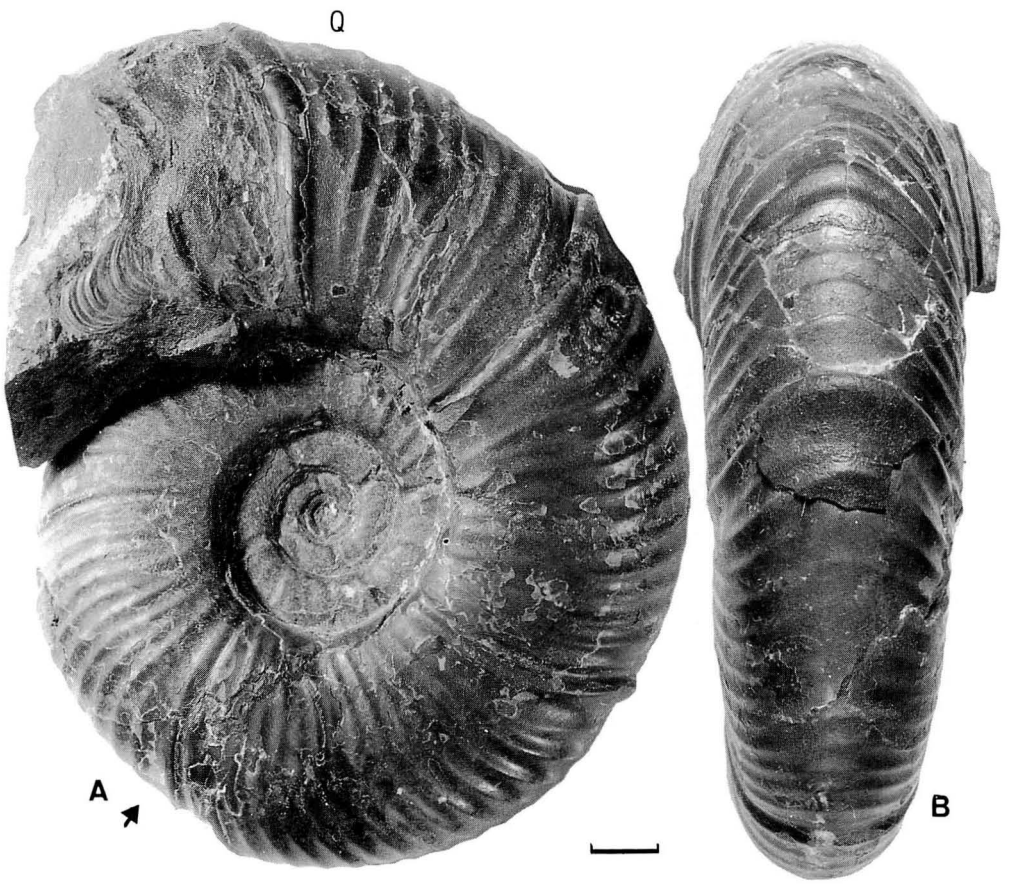


Figure 9. *Mesopuzosia pacifica* Matsumoto.
A—B: microconch, lappeted, MCM A111-2 from the Hakkin-zawa, Oyubari area (Coll. A. Tomita); scale bar = 10 mm. See Fig. 25B for the whorl-section at Q.

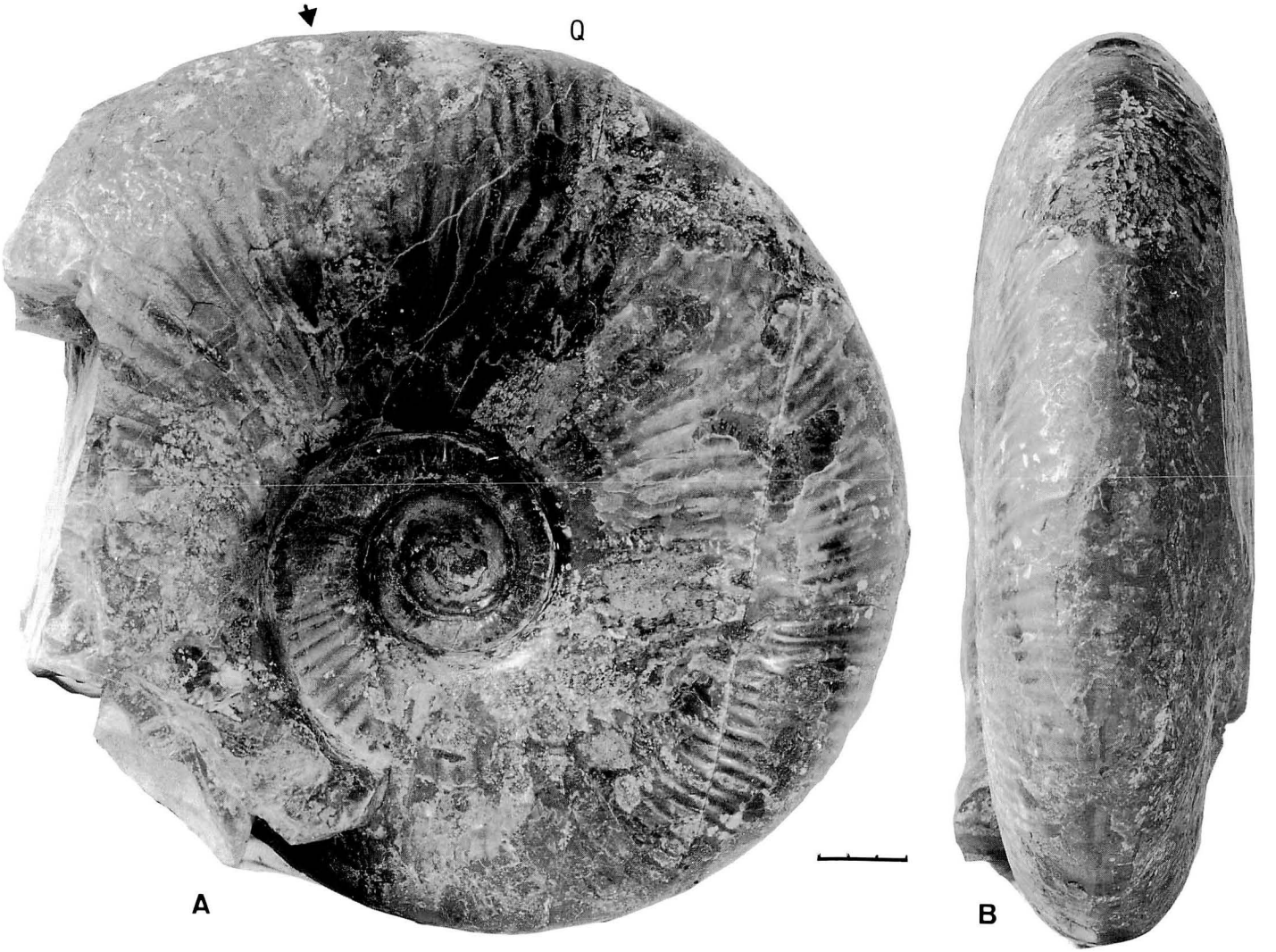


Figure 10. *Mesopuzosia pacifica* Matsumoto.
A—B: macroconch, YKC. 500629 (now kept at Mikasa City Hall) from the Kaneobets, Oyubari area (Coll. Y. Kawashita); scale bar = 30 mm. See also Fig. 25C for the whorl-section at Q.

margin (GK. H5665) was first noticed by Matsumoto and described in the discussion of *Kitchinites* (*Neopuzosia*) *haboroensis* Matsumoto et Inoma (1972, p. 390, text-fig. 9). At that time the authors hesitated to conclude the dimorphism, but now this is evident. Through a careful field work Takemi Takahashi obtained a much finer specimen (Fig. 8), which represents a microconch. It resembles the holotype quite well and is better preserved in showing the details of the apertural margin. Likewise, Mr. Akio Tomita's specimen, now kept at MCM. (Fig. 9), shows the peristome and is similar to Takahashi's in essential points.

Figure 11. *Mesopuzosia pacifica* Matsumoto.
Phragmocone of a macroconch, Y. Kera Coll. no. 475 from the Panke-moyuparo, Oyubari area; bar = 20 mm. See Fig. 25D for the whorl-section at Q.

The siphuncle ends at about the last fifth constriction and the head of the last suture is at some distance in front of that position. The body-chamber is 230° (± 10°) at the markedly projected last flare. At the peristome at some distance in front of the last flare there are a moderately projected rostrum and much elongated, tongue-like lateral lappets on which fine riblets and striae show gradually increasing convex curve toward the anterior end. The ventral rostrum has a few projected riblets on its basal part and fine striae on its apical part.

The last part of the body-chamber between somewhat approximated two flares are slightly more compressed than the rest main part and flattened on flanks where ribs weaken.

The main part of the body-chamber has gently convex flanks and moderately rounded venter. It has periodic constrictions and associated flares which are similar to but stronger than those of the phragmocone. They are slightly prorsiradiate or very gently arcuate (concave) on the inner main part of flank and curved gently forward on the ventrolateral part, crossing the venter with considerable projection. The ribs on the main part of the body-chamber are moderately strong and longer ones predominate. Some of them are fairly sigmoid on the flank and followed by intercalated or occasionally branched shorter ribs so that the interspaces may keep regular breadth. On the outer part all the ribs look uniform in their moderate projection and moderate intensity, whereas the periodic flares are stronger and slightly more projected than the normal ribs.

Slightly more than a half of the inner whorl is overlapped by the outer whorl. As the expansion ratio is moderate, the umbilicus is moderately wide and surrounded by low but nearly vertical wall and abruptly subrounded umbilical shoulder. The septate whorl is slightly more compressed than the main part of body-chamber and its venter is also a little more narrowly arched, except for the very young stage. It has well marked constrictions or distinct flares, numbering 6 per whorl. Sutures are exposed here and there on the internal mould or can be seen through semi-transparent inner shell layer. They are of typical *Puzosia* pattern.

Description of macroconch:—A completely preserved macroconch of this species is hardly obtained. YKC. 500629, now kept in the Public Hall of Mikasa City (Fig. 10) is fairly good in showing the late part of the phragmocone and also about 150° of the body-chamber, although the outer part of the latter is regrettably destroyed away. Y. Kera's no. 475 (Fig. 11) is almost wholly septate, nearly as large as the phragmocone of YKC. 500629, about 315 mm in diameter. The diameter of the complete macroconch is not precisely known, but presumably about 500 mm or more by a rough estimation from the above specimens.

In the late growth-stage the whorl becomes to be relatively higher, with decreasing ratio of B/H, showing distinctly smaller value than that of the microconch, or with increasing ratio of H/h or R/r (see *Dimensions*). The whorl-section is elongate subelliptical with the maximum breadth at about the mid-height. The flanks are gently convex, abruptly bent inward at the subrounded umbilical shoulder to the nearly vertical umbilical wall, and gradually converge outward to the rather evenly rounded venter. This outline of the section follows fundamentally that of the microconch or the inner whorl of the macroconch itself, with a change in the ratio of B/H. The degree of involution does not change significantly, being almost the same as that of the microconch. The umbilicus is, however, comparatively narrower in the macroconch on account of the larger increase of whorl-height.

In the late stage of the phragmocone, there are numerous and dense ribs, of which longer ones starting at or near the umbilical rim are predominant and gently sigmoidal, whereas more or less shorter ones are sometimes intercalated at about the mid-flank or on still outer part. All

the ribs are moderately projected on the ventral part. Compared with the ribs on the outer whorl of microconch, they are denser, narrower and more numerous. Constrictions become indistinct, seemingly less frequent and where present they are shallow and narrow. Likewise flares are infrequent or indistinct, discernible as low and weak ones or as slightly more elevated ribs than the normal long ones.

The body-chamber may be weakly ribbed on its posterior portion but is nearly smooth on the main part, where blunt but major radial elevations appear around the umbilicus, fading away outward.

Observations:—The holotype (GK. H1257) (Matsumoto, 1954b, pl. 15, fig. 1) is probably an adult microconch, because it closely resembles the above described fine example (TTC. 530806), but regrettably it lacks the last part of the body-chamber. It was wrongly regarded as middle-aged, for the dimorphism was not known at that date. The illustrated paratype (*op. cit.*, pl. 15, fig. 2) is probably a middle aged part of a macroconch, for it has still outer whorls, though much damaged.

The shell-form and sutural development in early growth-stages up to 10 mm in diameter have been illustrated already (Matsumoto, 1954b, text-fig. 2). The ontogenic development of the suture on a specimen from Sakhalin has been observed in detail by Mikhailova (1983, fig. 80). Although the sutural elements are expressed in Russian style, her illustration is not significantly different from Matsumoto's. One point to be examined may be how to express the suspensive lobe, in other words, how to follow the subdivision of U1 or U3.

At this young stage the whorl is broader than high and subrounded in section. The surface is smooth, but for several constrictions, which are gently concave forward.

In the succeeding parts the whorl is nearly as high as broad and then becomes somewhat higher than broad. At this late early growth-stage, at D = 20 mm or so, fine radial lirae appear on the shell surface. They gradually strengthen with growth through subcostae to the ribs on the main part of the phragmocone.

Comparison:—See the description of other species of *Mesopuzosia*.

Occurrence:—Although some specimens were obtained as boulders on the floor of rivers, the available evidence tells that this species occurs commonly in the Zone of *Inoceramus hobetsensis* in various areas (Shiyubari, Oyubari, Ashibetsu, Obira, Saku etc.) of Hokkaido, Middle Turonian. Previous records in higher part should be examined, for *M. indopacifica* (Kossmat) was sometimes misidentified with *M. pacifica*.

Mesopuzosia takahashii sp. nov.

(By T. Matsumoto)

Figures 12—18; 25E

1954b. *Jimboiceras planulatiforme* (Jimbo); Matsumoto, p. 97 (pars).
1955. *Mesopuzosia* cf. *pacifica* Matsumoto; Hayasaka, p. 37.
1983 *Jimboiceras planulatiforme* (Jimbo); Hayami and Maeda, p. 83.

Holotype:—TTC. 570926 (Figs. 12, 13), found by T. Takahashi from the mudstone exposed at loc. Yb 10500 (of T. T.) [= Y5323 of T. M.], on the left side of the lower course of the Kaneobets, a tributary to the River Yubari, Oyubari area.

Paratypes:—Numbered as in parentheses for convenience' sake: (1) GK. H8122 (Fig. 15A—D)

from Ik 2014d, Pombets. Ikushumbets area (T. T. & T. M. Coll.); (2) GK. H8124 (Fig. 14) from the Hakkin-zawa, Oyubari area (T. Takahashi Coll., donated to GK. through T. M.); (3) No. 387 of Y. Kera's Coll. (Fig. 16), obtained from a boulder (nodule) of the Kaneobets, at some distance upstream of the type locality; (4) NSM. P1-3500 (Fig. 17), collected by Dr. H. Shimogawara, Chief Geologist of the Hokkaido Colliery and Steamship Company at that date, from the silty fine-grained sandstone of the upper part (Mk 4) of the Mikasa Formation, exposed at loc. Yb 29 on the right bank of the Shihorokabetsu, and donated to NSM (see Hayasaka, 1955, p. 37; Matsumoto and Harada, 1964, p. 89); (5) GK. H8256 from loc. H005 of the Hachigatsu-zawa, tributary to the River Ashibetsu (Coll. H. Hirano and T. Matsumoto); (6) GK. H8257 [= TTC. 530910] (Fig. 15E—H) obtained by T. Takahashi from a branch of the Poroko-ashibetsu, tributary to the River Ashibetsu; (7) TTC. 501123, T. Takahashi Coll. from the 5th branch of the Kami-ichi-no-sawa, Ikushumbets area; (8) UMUT. MM 6646B [= GT. I-2651B] (Fig. 18) from loc. I 236 p, the first tributary of the Aikawa in the University Forestry attached to the University

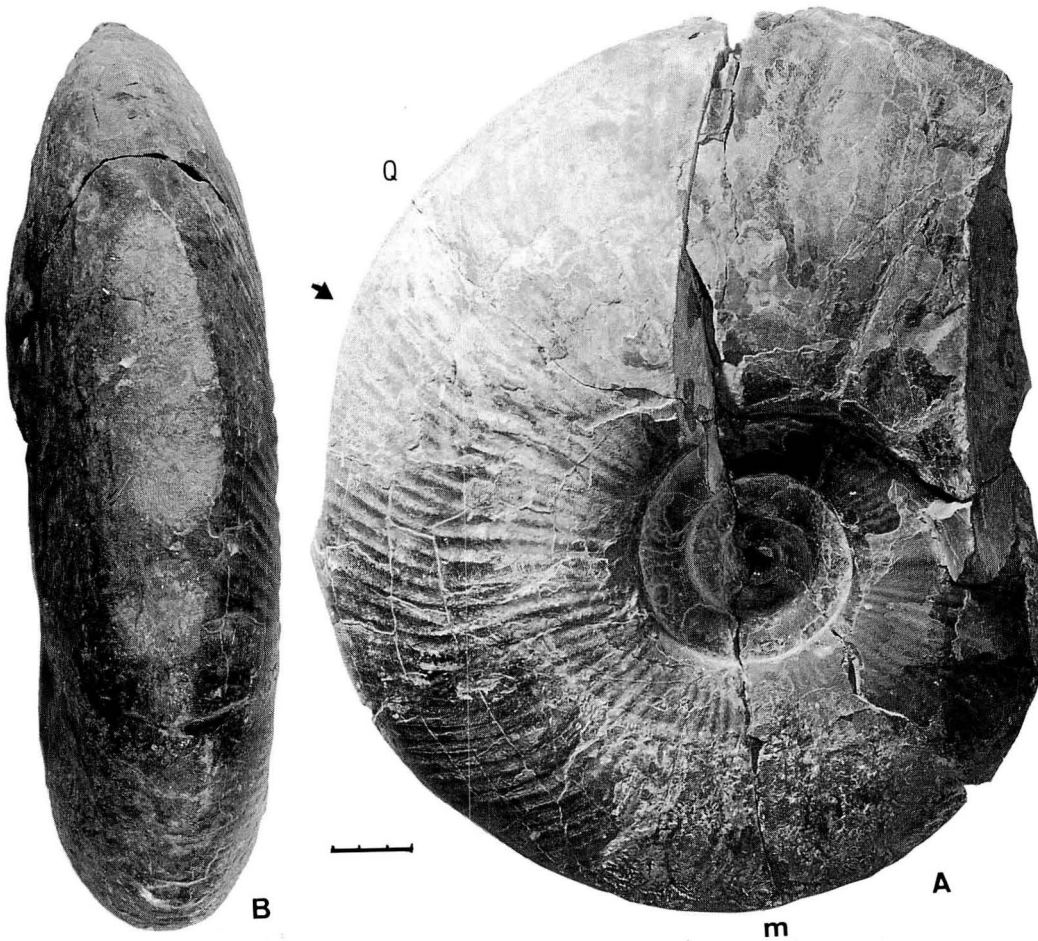


Figure 12. *Mesopuzosia takahashii* Matsumoto, sp. nov.
A—B: holotype, TTC. 570926 from loc. Y5323, Kaneobets, Oyubari area, macroconch (Coll. T. Takahashi); scale bar = 30 mm. See also Fig. 25E for the cross-section at Q.

Figure 13. *Mesopuzosia takahashii* Matsumoto, sp. nov.
A—C: a part of the holotype (TTC. 570926) earlier than the stage marked as m in Fig. 12A; bar = 30 mm.

of Tokyo at that date, South Sakhalin (T. M. Coll. in 1937; see Matsumoto, 1942 for the location; Matsumoto, 1954b, p. 97 under *Jimboiceras planulatiforme*).

Diagnosis:—Young shell less than 70 mm or so in diameter similar to that of *M. pacifica* in having moderately frequent and well-marked constrictions or flares and more or less flexuous, fine ribs as well as in shell-form.

Shell in the middle growth-stage, e.g. D = 70 to 150 mm in the holotype, not so high-whorled as in later stages, indicating for instance B/H = 0.87 to 0.81 (decreasing with growth) in the holotype, subcordate or thickly subovoid in whorl-section, broadest in the dorsal part, with somewhat convex flanks which converge to narrower ventral part; umbilicus of moderate width, surrounded by steeply inclined wall and subrounded shoulder. Ribs in this stage of moderate intensity, rather narrow but fairly distinct and numerous, many of which long with unequally shorter ones intercalated at various places on the flank; subradial on inner flank and curved forward on outer flank, projecting on the venter. Some ribs may be gently sigmoidal on side but not so distinctly flexuous as those of *M. pacifica*. Flares and constrictions of moderate frequency similar to the long ribs in curvature.

Adult microconch similar to the middle-aged macroconch in size and other features, except for the peristome. Trace of peristome may remain in front of some constrictions.

Shell in the late growth-stage of macroconch moderately involute and fairly narrowly umbilicate; high-whorled, longish suboval in section, broadest in the dorsal part, with gently convex flanks which converge outward to rather narrowly arched venter. Ribs of unequal length, numerous and rather crowded, with longer ones predominant, subradial or sometimes gently sigmoidal on the main part of flank, gradually curved forward on the outer flank, passing into the venter with considerable projection. Ribs on the large outer whorl gradually weaken with growth; flares also weaken and constrictions shallowed, both becoming hardly discernible on the outer part. Finally the surface become nearly smooth and blunt, radial undulations may appear around the umbilicus. Macroconch may become huge at the full-grown stage.

Dimensions:—

Specimen	D	U	H	B	B/H	H/h	R/r	Inv
Holotype								
LS + 85°	360.0	96.0 (.27)	169.0 (.47)	—	—	—	—	—
LS + 50°	326.0	88.0 (.27)	146.0 (.46)	92.0 (.29)	0.63	1.59	1.57	0.57
LS	290.0	82.0 (.28)	128.0 (.44)	87.0 (.30)	0.68	1.68	1.57	—
LS − 140°	206.0	65.0 (.31)	90.0 (.44)	73.0 (.35)	0.81	1.76	1.57	0.60
Paratype (1) LS	—	—	35.3	29.5	0.84	—	—	—
(1) LS − 70°	80.0	28.6 (.36)	30.3 (.38)	26.0 (.33)	0.86	—	1.44	—
(2) LS + 200°	140.5	45.5 (.32)	57.0 (.41)	47.8 (.34)	0.84	1.50	1.43	0.54
" LS	90.0	31.4 (.35)	36.3 (.40)	30.4 (.34)	0.84	—	—	—
(3) LS	153.0	47.2 (.31)	63.2 (.41)	40.0 (.26)	0.63	1.58	1.53	—
" LS + 120°	215.0	61.0 (.28)	95.0 (.44)	—	—	1.64	1.55	0.54
(4) E	730.0	190.0 (.26)	320.0 (.44)	265.0 (.36)	0.83	1.49	1.48	0.64
" E − 350°	—	110.0	168.0	126.0	0.75	—	—	—
(5) E − 180°	175.0	55.0 (.31)	74.0 (.42)	61.0 (.35)	0.82	1.61	—	—
(6) E − 90°	74.4	27.5 (.37)	27.0 (.36)	21.4 (.29)	0.79	1.36	1.40	0.59
(7) E − 45°	70.8	27.7 (.39)	25.8 (.36)	20.0 (.28)	0.78	1.37	—	—
(8) E	164.0	54.5 (.33)	67.5 (.41)	51.5 (.31)	0.76	1.61	1.52	0.60
E − 180°	116.0	39.5 (.34)	43.8 (.38)	35.0 (.30)	0.80	—	—	—
For comparison								
BM. C12229a	—	—	55.0	43.0	0.78	—	—	—
BM. C79501	83.0	26.5 (.32)	37.0 (0.45)	28.0 (.34)	0.76	—	—	—
R. & M.	181.0	48.0 (.27)	84.0 (.46)	66.0 (.36)	0.79	1.70	1.65	0.53

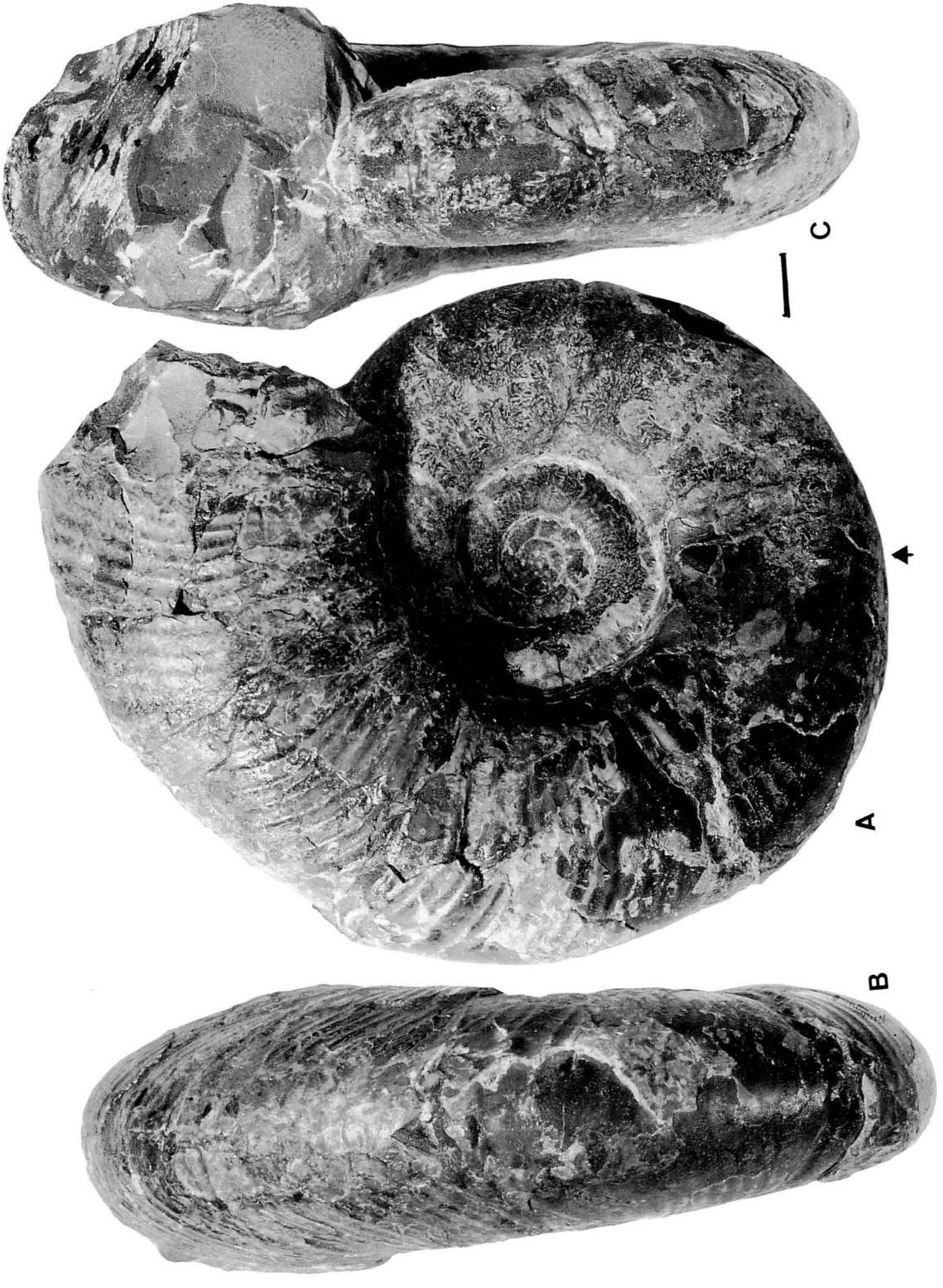

C
A
B

Figure 14. *Mesopuzosia takahashii* Matsumoto, sp. nov.
A—E: microconch, GK. H8124 from the Hakkin-zawa, Oyubari area (Coll. & donated by T. Takahashi); bar = 10 mm. D and E show a trace of lappet and disordered ribbing in front of it (in two different lights).

BM. C12229a = lectotype of *P. curvatisulcata;* BM. C79501 = *P. curvatisulcata* of Wright (1979, pl. 4, fig. 4), measured by T. M.; R. & M. = holotype of *M. gaudemarisi* (Roman et Mazeran), measured on the photographs, in which the rursiradiate section of whorl in fig. 1a is revised to the correct estimation.

Observations:—The holotype is fairly well preserved, but the body-chamber is incomplete. The phragmocone ends at about 290 mm in diameter. The restored entire shell must have been at least 520 mm in diameter. As the constrictions and flares become indistinct on the late part of the phragmocone and the ribs are weakening on the preserved posterior part of the body-chamber, this large shell probably represents a macroconch. Owing to its favourably separable state, some characters at the middle and earlier growth-stages are observable. Apart from the above diagnosis, on a part of the whorl with height of 50 to 60 mm, ribs are bent abruptly at the mid-flank and projected markedly forward on the outer part. This reminds us of similar ribbing on a part of the body-chamber in the lectotype of *Jimboiceras planulatiforme* (Jimbo), but the ribs are not bifurcated and the flares are not so thick as in the latter. This peculiar feature in a portion of the holotype is probably a disorder caused by a kind of pathology as suggested by an oblique groove or disordered constriction on the inner flank of that part.

Paratype (1) (Fig. 15A—D) is incompletely preserved but important in that it represents a microconch. It is much smaller than the holotype but shows the last suture and the succeeding part of the body-chamber. It resembles the middle aged shell of the holotype in the general aspects but the ribs on the body-chamber are somewhat coarser and more distinct despite the condition that it is an internal mould. Moreover a trace of lateral lappet is discernible in front of the last constriction of the phragmocone.

Paratype (2) (Fig. 14) is less deficient than the paratype (1) and has the last septum at nearly the same position (D = *c.* 90 mm) as that of the latter. It preserves the body-chamber for about 200° but the last marginal part is regrettably unpreserved. In front of the constriction at about the last septum the ribs are coarser and show peculiar bending on both sides, suggesting a kind of lappet trace. The ribs and flares or constrictions on the rest main part of the body-chamber are similar to those of the middle-aged shell of the holotype and other specimens of macroconchs. In the preserved last portion on the right side of this specimen (paratype 2) the ribs are much weakened, suggesting the last part immediately behind the marginal part. Anyhow, the paratypes (1) and (2) certainly represent the microconch of this species. The diameter of the microconch must have been 140 to 150 mm in these examples. The restored diameter of the holotype (a macroconch) (mentioned at the beginning of *observations*) is 3.7 to 3.5 times as large as this size.

Paratype (3) (Kera's no. 387) (Fig. 16) is fairly well preserved on the right side, with test attached on major part, but the left side is dissolved in rock matrix and the body-chamber is distorted and broken, without the later half. Therefore its whorl-breadth (B and B/H) is roughly estimated. Its phragmocone ends at D = 153 mm and is much smaller than that of the holotype, but evidently larger than that of the above two examples of microconchs. Despite the well preserved shell-layers there is no trace of lappet at about the end of phragmocone; some of the ribs in front of the constrictions or flares show a slight sinuosity and similarly gently sigmoidal ribs occur also on some other parts. Therefore, I am inclined to regard this specimen an example of macroconch at a middle growth-stage.

On the other hand, NSM. P1-3500 (Fig. 17) is too large to be compared with the holotype and other examples. It is seemingly similar to GK. H5994 in size and shell-form, but dissimilar in the

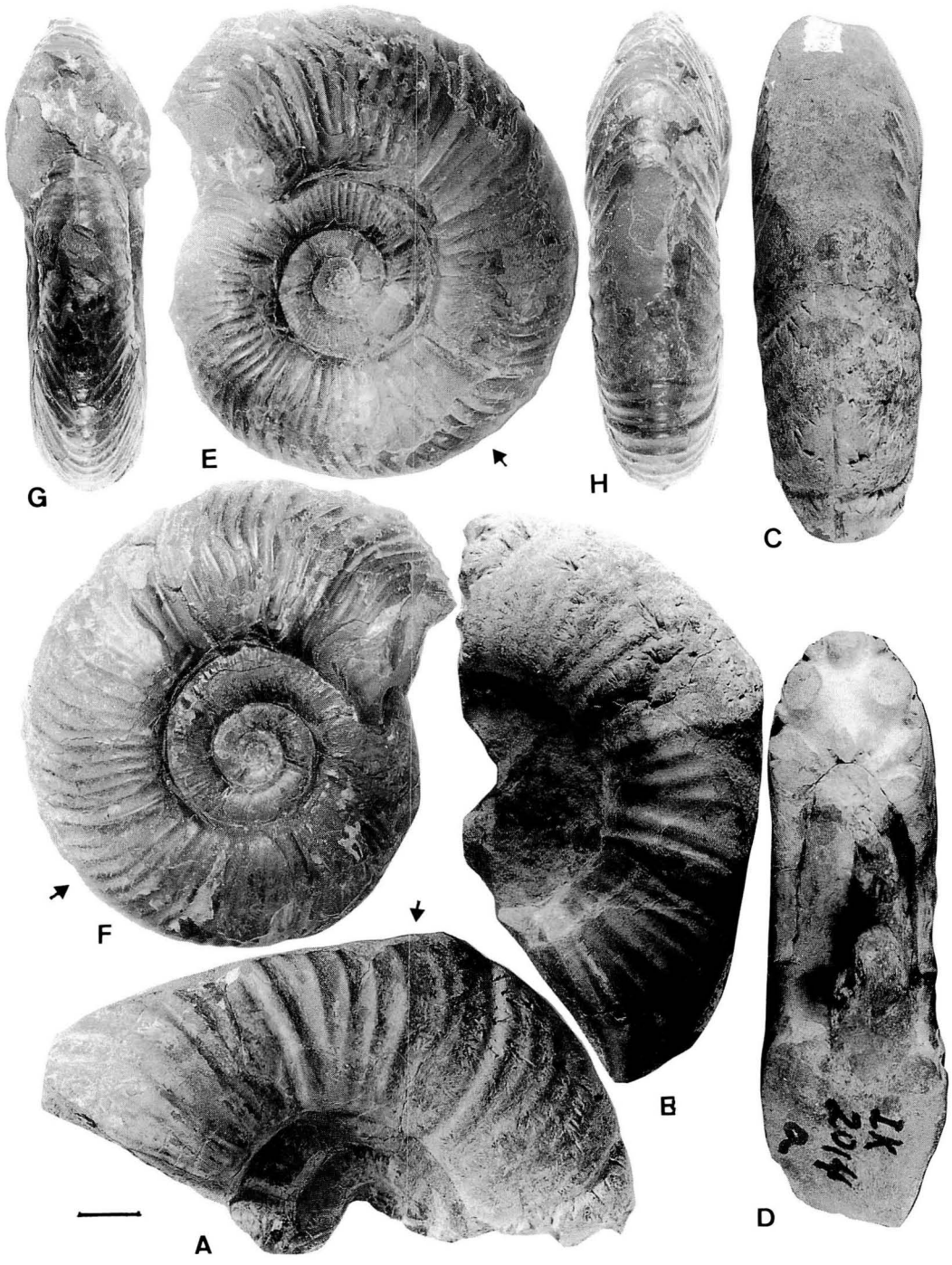
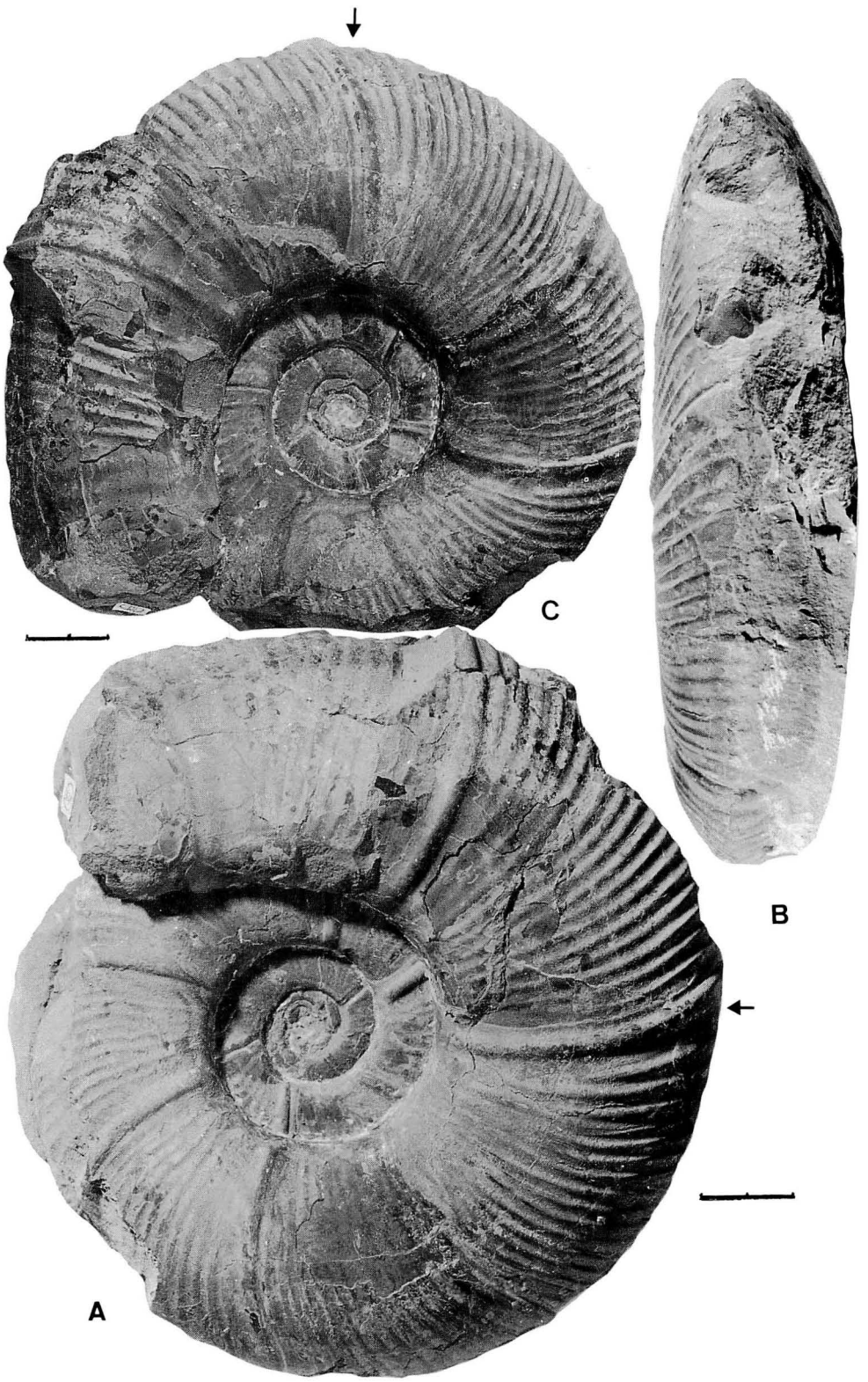


Figure 15. *Mesopuzosia takahashii* Matsumoto, sp. nov.
A—D: microconch, GK. H8122 from loc. Ik 2014d, Pombets, Ikushumbets Valley (Coll. T. Takahashi and T. Matsumoto); E—H: *Ditto,* GK. H8257 (= TTC. 530910) from the Poroko-ashibetsu, Ashibetsu area; scale bar = 10 mm.


C
B
A

ribbing. The latter is an example of *Pachydesmoceras pachydiscoide* Matsumoto (this paper, p. 127) but the former has denser and narrower ribs, some of which are gently sigmoidal on the main flank and moderately projected on the outer part. Therefore I have listed this specimen as paratype (4) of this species.

Paratype (5) (Fig. 18) was once listed under *Jimboiceras planulatiforme* (Jimbo) (Matsumoto, 1954b, p. 97), but this was a mistake from my misunderstanding (see revised description in p. 89 of this paper). It is generally similar to paratype (3) and shows the change of whorl-section with growth, keeping subovoid to suboval outline. It is, however, wholly septate and has a trace of the umbilical seam of a full outer whorl. It is fairly large (D = 164 mm) but must be a nucleus

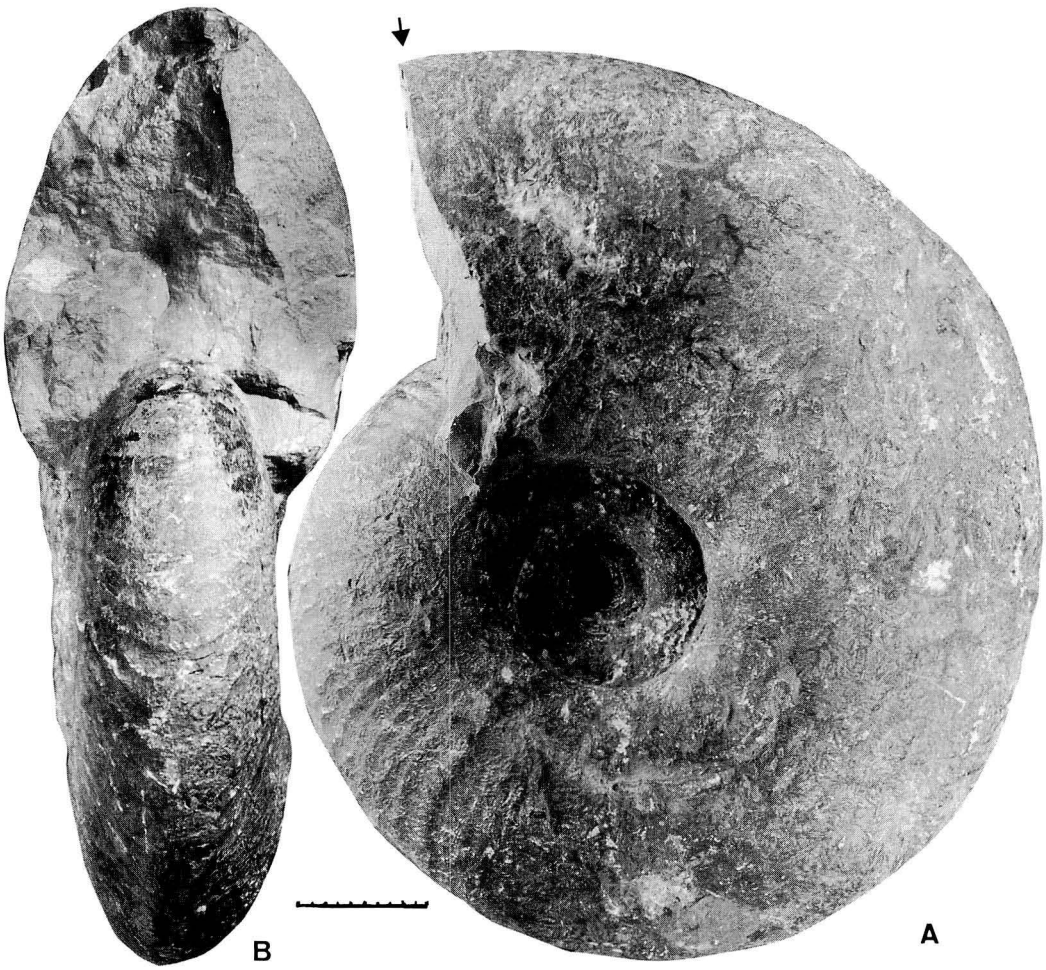


Figure 17. *Mesopuzosia takahashii* Matsumoto, sp. nov.
A—B: huge macroconch, NSM. P1-3500, from loc. Yb 29, Yubari (Coll. & donated by H. Shimogawara); scale bar = 100 mm. Photo by Dr. T. Kase.

← Figure 16. *Mesopuzosia takahashii* Matsumoto, sp. nov.
A—C: Y. Kera Coll. no. 387 from the Kaneobets, Oyubari area, middle-aged macroconch (?); scale bar = 20 mm. C is turned about 90° anti-clockwise from A and reduced in size.

of a still larger or possibly huge specimen.

A specimen collected by H. Maeda from the Oku-futamatagawa, Obira area, now on display at the entrance of UMUT, labelled as *Jimboiceras planulatiforme* (Jimbo) (see Hayami and Maeda, 1983, p. 84) is, in my opinion, probably another huge example of this species. It is about 700 mm in diameter and still septate at its preserved end. It would match well with the above mentioned paratype (5) as its nuclear inner whorls.

Comparison and discussion:—This species is similar to *M. pacifica* in the general aspects but is distinguished in its shortly subovoid to longish suboval whorl-section instead of subrounded to subelliptical one in the middle to late growth-stages, with the maximum breadth in the dorsal part instead of at about the mid-height. In the same growth-stages, the ribs are very gently or indistinctly flexuous or rather gently arcuate in this species, whereas more distinctly sigmoidal ribs occur frequently in *M. pacifica*.

This species resembles *M. gaudemarisi* (Roman et Mazeran) (1913, p. 19, figs. 1, 2), from the Turonian of the Ucheux Basin, France. The paratype (3) of the former is indeed similar to the holotype of the latter in lateral view. But *M. takahashii* differs from that species in its subovoid whorl-section which is broader in the dorsal part and narrowly arched on the venter, whereas the latter shows rather subelliptical section with an evenly rounded venter. In this respect the French species may be similar to *M. pacifica* but the latter has more distinctly sigmoidal ribs.

The lectotype of *Puzosia curvatisulcata* Chatwin et Withers (1909, pl. 2, figs. 1—2) resembles the middle-aged whorl of this species in the outline of the cross-section. Its ribs of the actual specimen is much weaker than those on the illustration and seem to be confined to the outer part. As the specimen is an internal mould of a fragmentary whorl, the characters are not precisely known. Paratype 1 of *M. takahashii* is also an internal mould but shows more distinct ribs, many of which arise from the umbilical rim. The same feature is shown in paratype 2 on the outer and inner whorls; also on the shell surface and internal mould. Thus, some difference in the ribbing seems to exist between the two species. As the original specimens of the British species are poorly preserved, it is difficult to lead a definite conclusion about the comparison of this species with *P. curvatisulcata*.

Wright (1979, p. 308) attempted to redefine *P. curvatisulcata* Chatwin et Withers, 1909, with which *P. gaudemarisi* Roman et Mazeran, 1913 and *P. orientalis* Matsumoto, 1954b were regarded as synonyms. There are, however, some doubts, as I mentioned above and also in the redescription of *P. orientalis* (this paper, p. 39).

At the moment, I think it better to establish *Mesopuzosia takahashii* sp. nov., giving clear description. As a possibility one could assume that *M. takahashii* would be a subspecies of *M. gaudemarisi* or *M. curvatisulcata,* but that should be concluded on the evidence of sufficient material.

The middle-aged shell of *M. takahashii* looks somewhat similar to *Jimboiceras planulatiforme* (Jimbo). The latter, which is to be described in later pages, has a smaller ratio of whorl expansion, somewhat wider umbilicus, relatively broader whorl, sometimes bifurcate ribs and in the mature shell thick and frequent flares. The difference between the adult macroconchs is great between the two species (see the description in later pages).

Occurrence:—The mudstone of the type locality (Y5323) on the Kaneobets of the Oyubari area is assigned to the lower part of the Middle Turonian, because it is somewhat below the Zone of *Inoceramus hobetsensis* and because *Inoceramus* sp. nov. (?) aff. *I. hobetsensis* Nagao

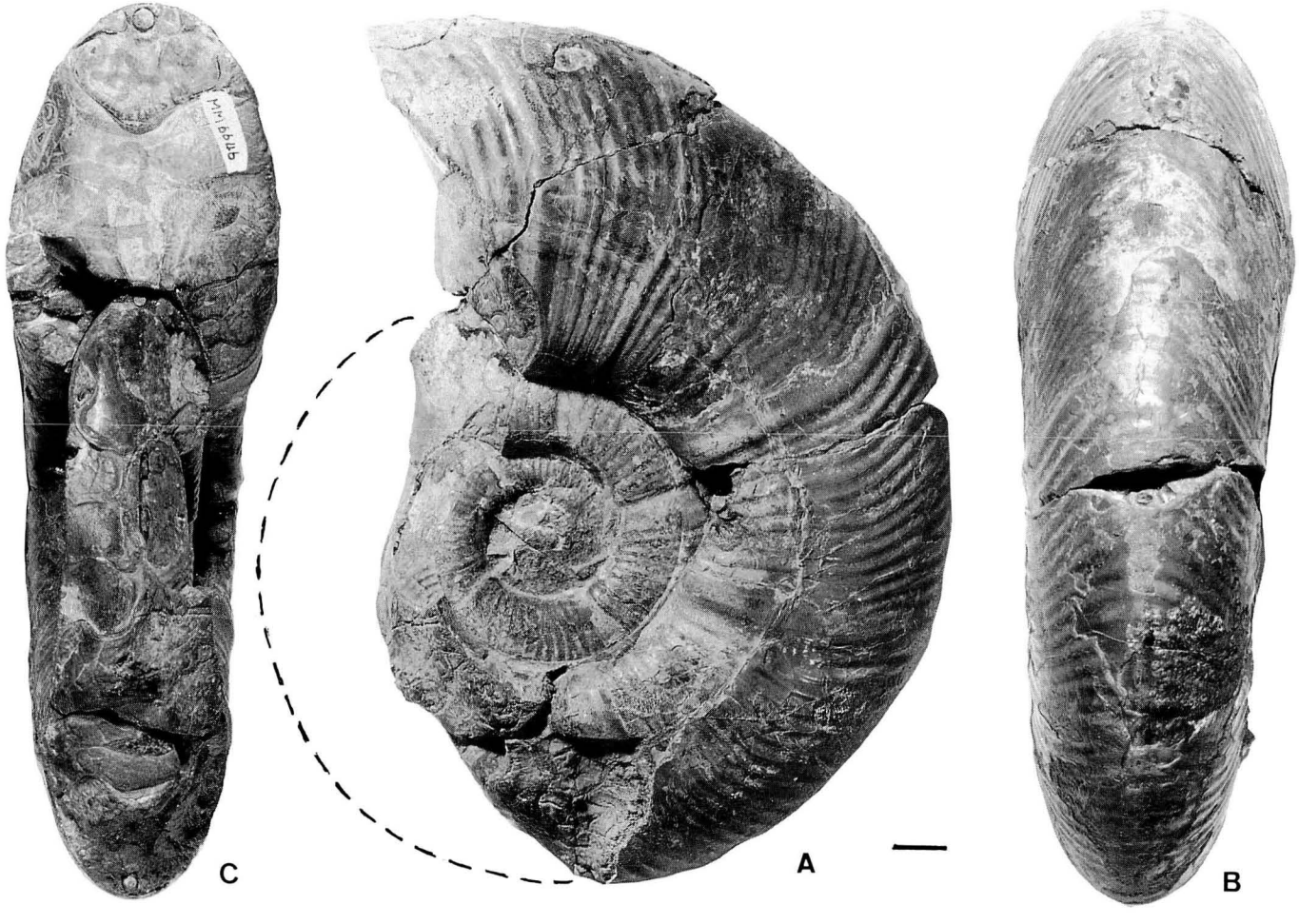


Figure 18. *Mesopuzosia takahashii* Matsumoto, sp. nov.
A—C: nuclear part of macroconch, UMUT. MM 6646B from loc. I236p, the Arkawa Valley, South Sakhalin (Coll. T. Matsumoto); bar = 10 mm.

et Matsumoto and *Mammites costatus* Matsumoto et Kawashita, among others, have been obtained from the nearby localities.

Paratypes (2) and (3) are probably also from the Middle Turonian of the Oyubari area, whereas paratypes (1), (4) and (7) were obtained from the Upper Turonian of the Mikasa (i.e. Ikushumbets) and Yubari areas. Paratypes (5) and (6) from the middle or upper part of the Turonian (possibly but doubtfully Coniacian for 6) of the Ashibetsu area.

Paratype (8) came from somewhere in the Miho Group of South Sakhalin.

Mesopuzosia aff. *chivensis* (Arkhanguelsky)

(By T. Matsumoto and H. Kokubun)

Figures 19—20

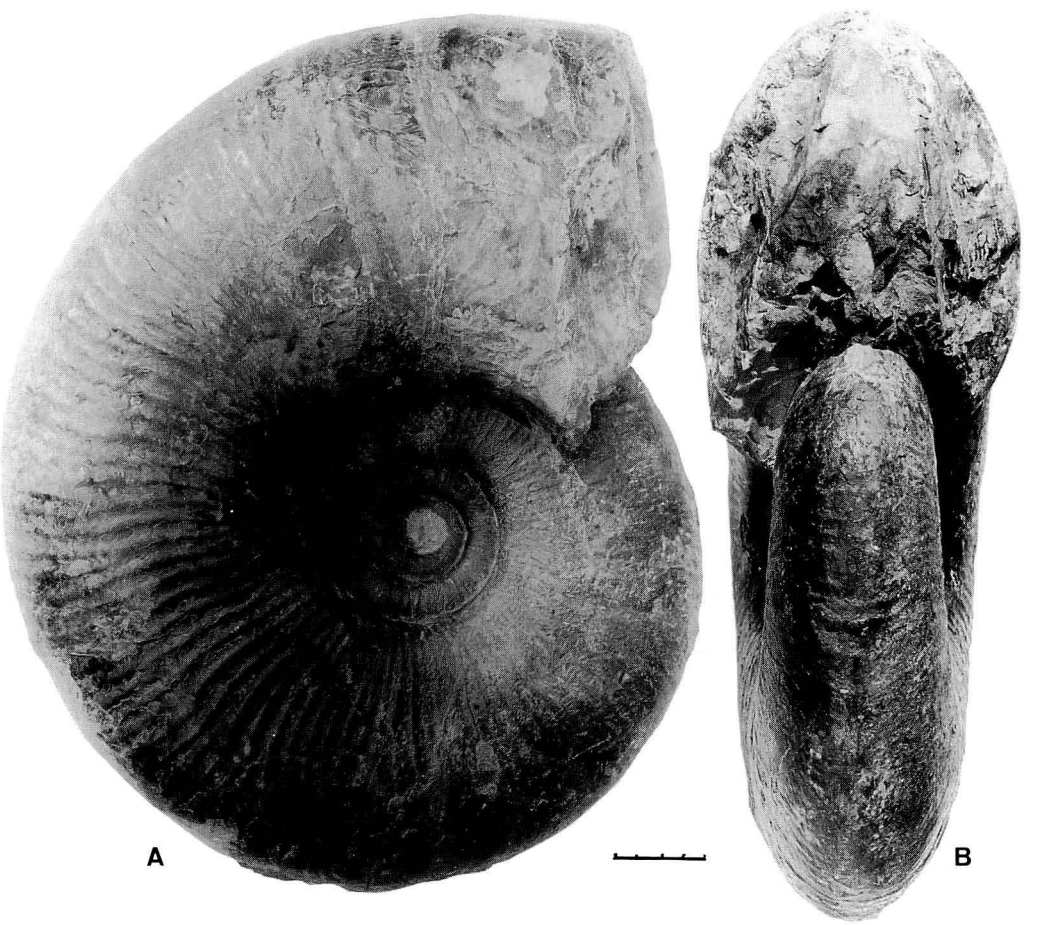


Figure 19. *Mesopuzosia* aff. *chivensis* (Arkhanguelsky).
A—D: macroconch, H. Kokubun Coll. 560524 from loc. R2243,

Compare:—

1916. *Puzosia chivensis* Arkhanguelsky, p. 34, pl. 5, fig. 13; pl. 6, fig. 6.

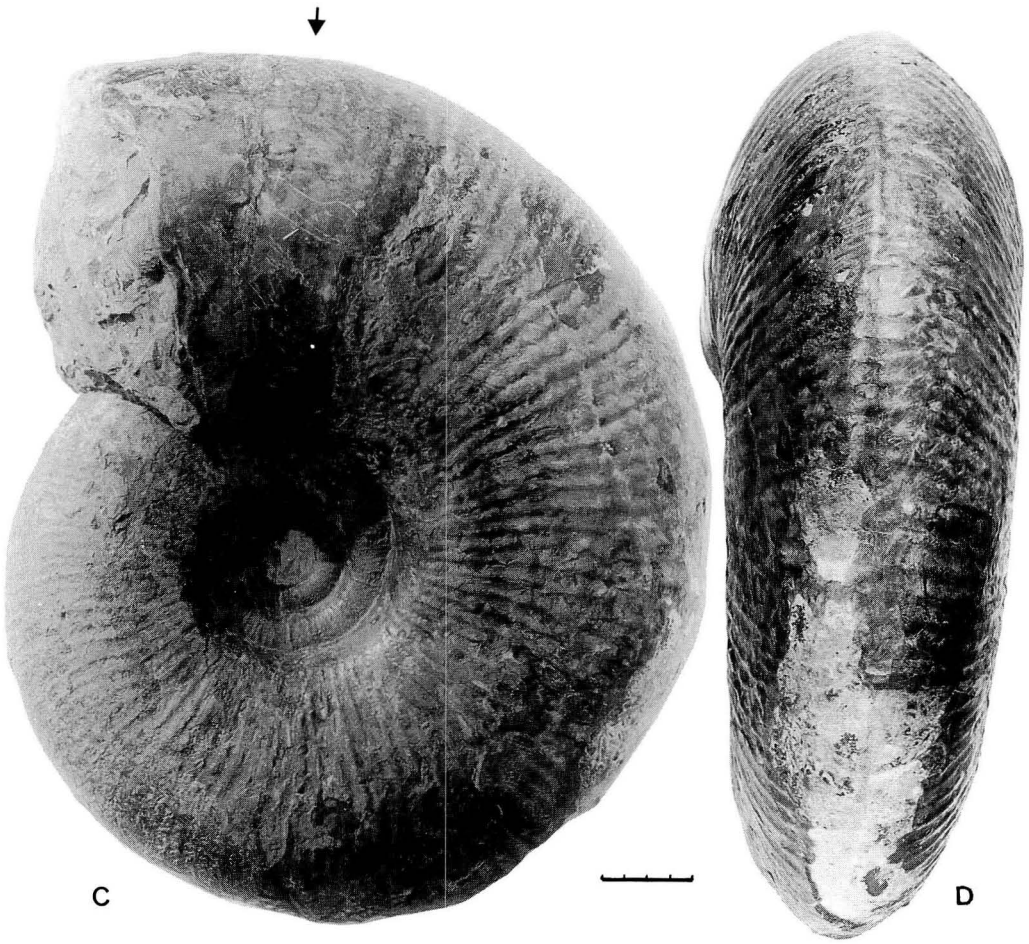
Material:—H. Kokubun's Collection 560324 (Fig. 19), from loc. R2243, Kami-kinembets, Obira area (see Tanabe *et al.*, 1977, fig. 9 for the location); IGPS. 98918 (Fig. 20), without locality record.

Dimensions:—

Specimen	D	U	H	B	B/H	H/h	R/r	Inv
HKC. LS	384	99 (.26)	164 (.43)	131 (.34)	0.80	1.42	1.42	0.56
HKC. LS-200°	—	—	87	67	0.77	—	—	—
IGPS. E	558	153 (.27)	227 (.42)?	153 (.27)?	0.67	—	—	—
Ark. fig.	182	51 (.28)	77 (.42)	64 (.35)	0.83	1.46	1.50	0.60

HKC. = H. Kokubun, Coll. 560324; IGPS. = IGPS. 98918; Ark.(fig.) = *M. chivensis,* holotype; measurements on the illustration, which are the same as Arkhanguelsky's, except for U.

Description:—HKC. 560324 is a well preserved phragmocone, with a fraction (about 20°)



bed with *Yubariceras yubarense,* Obira area; scale bar = 40 mm.

of the body-chamber remained. On the assumption that the body-chamber occupied at least 210°, the entire shell diameter would be about 650 mm. This specimen is probably a macroconch. The diagnostic characters shown by this specimen are as follows:

Shell very large; outer whorl higher than broad, with B/H = 0.8 in the late part and somewhat smaller in the early part, broadest at about one third of the height, thickly suboval in section, with fairly convex flanks which converge to moderately rounded venter; umbilicus rather narrow for the genus, surrounded by moderately high and nearly vertical wall and subrounded shoulder; expansion of whorl moderate in height and breadth both; involution moderate, a little more than a half of inner whorl being overlapped by the outer one.

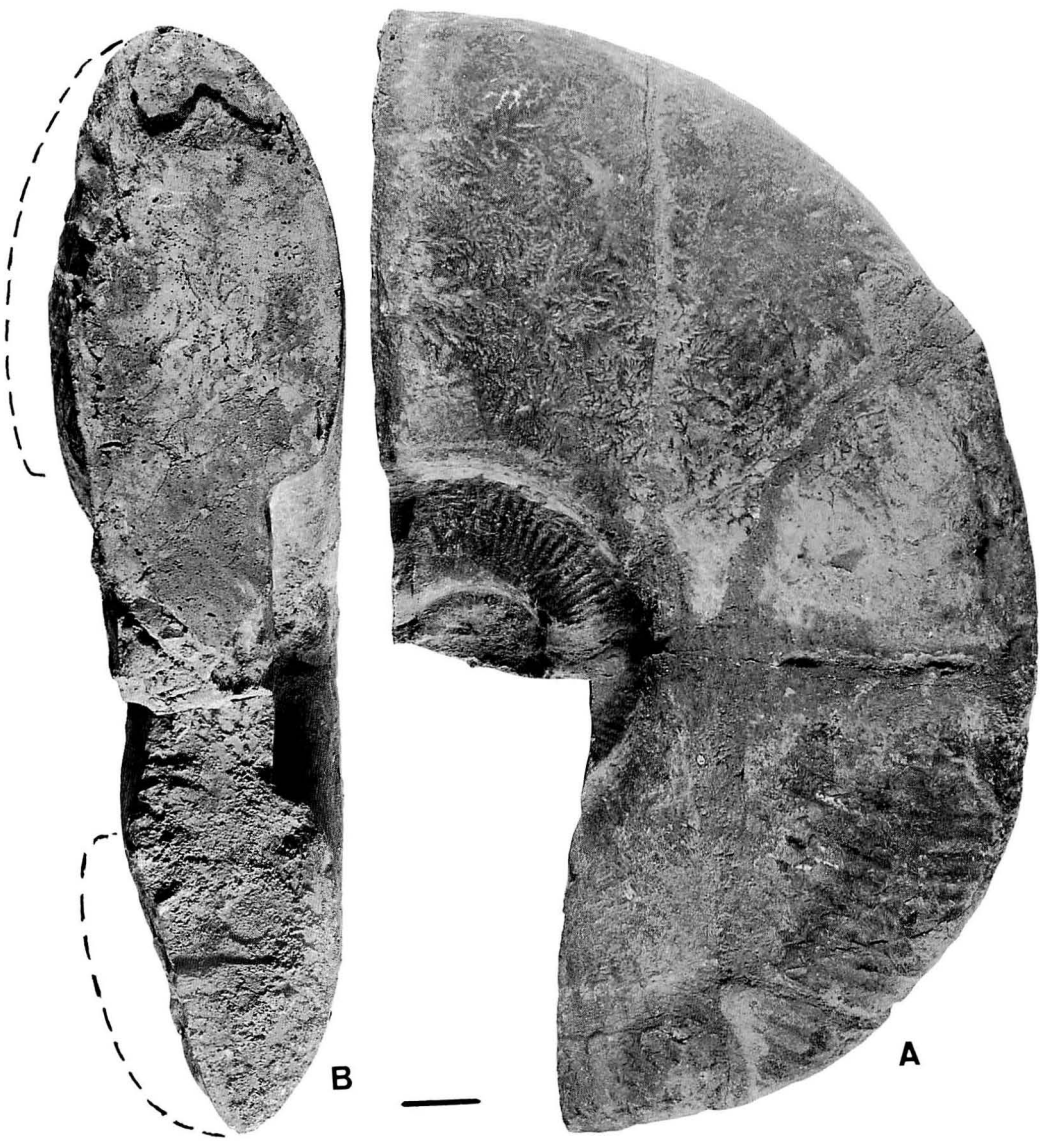


Figure 20. *Mesopuzosia* aff. *chivensis* (Arkhanguelsky).
A—B: macroconch, IGPS. 98918 (secondarily compressed) without locality record; bar = 40 mm.

Constrictions and associated flares of moderate frequency, distinct on inner whorls but weakening on the late part of the phragmocone. Ribs fairly dense, numerous and of unequal length; longer ones reach or very nearly reach the umbilical shoulder; shorter ones mostly on outer half but occasionally somewhat longer or shorter, as a rule alternated with the longer ones; altogether about 20 ribs per 45°. The ribs and flares (or constrictions) gently but characteristically sigmoidal on the flank and weakly projected outward. They weaken on the last part of the phragmocone, which is followed by nearly smooth body-chamber.

IGPS. 98918 is larger than HKC. 560324, still septate at its preserved end, where D = 558 mm, but incomplete and secondarily compressed and only the weathered right side is shown. Its dimensions, especially of B and B/H, are not precise. When its body-chamber was preserved. its entire diameter must have exceeded 800 mm. Its mode of ribbing is quite similar to that of HKC. 560324, though somewhat weathered. Much intricate, finely and deeply incised suture is exposed on the late part of the preserved outer whorl.

Comparison and discussion:—The two specimens described above are not identified with any hitherto known species from Hokkaido and Sakhalin. They probably represent a species which is rare and new to Hokkaido. In the subovoid whorl-section, with the maximum whorl-breadth in the dorsal part, and the densely disposed numerous ribs, this species is somewhat similar to *M. takahashii* sp. nov. described in the preceding pages, but the ribs are gently sigmoidal on the main flank and weakly projected outward in the former, whereas they are mostly rather subradial, only occasionally gently sigmoidal on the main flank and distinctly projected on the outer part in the latter; the venter of the latter is more narrowly arched as compared with the moderately and evenly rounded one in the former.

This species is distinct from *M. pacifica* Matsumoto in that the latter has subrounded to subelliptical whorl-sections with the maximum breadth at about the mid-height, somewhat wider umbilicus, thicker flares and coarser, less numerous and more distinctly sigmoidal ribs which are moderately projected on the outer part.

Amongst the species hitherto reported outside the Japanese province, *Puzosia chivensis* Arkhanguelsky (1916, p. 84, pl. 5, fig. 13; pl. 6, fig. 6), from the Lower Turonian of Turkestan, is worthy to be compare with this species. It is similar to ours in the characteristic shell-form and ornamentation. The umbilicus was estimated as moderately wide (U/D = 0.32) by Arkhanguelsky but fairly narrow (U/D = 0.28) as the photograph shows. The ribs are curved weakly foreward on the outer part of the whorl. The holotype may be a microconch.

The Japanese form has more numerous and finer ribs, most of which are weakly sigmoidal on the flank, whereas the Turkesten form has somewhat coarser ribs (where the test is preserved), which seem to be gently concave for the major part and occasionally some of which are weakly sigmoidal. Anyhow, *P. chivensis* is an example of *Mesopuzosia,* as it has numerous, distinctly long ribs which reach the umbilical margin and also the intercalated shorter ones.

The above comparison is made between the specimens of different sizes of probably dissimilar growth-stages and the available specimens are few in both provinces. Therefore, we hesitate to establish a new species for the Hokkaido form. The latter could possibly be either an allied but separate species or a geographical subspecies of *M. chivensis.* Until the sound evidence is consolidated on sufficient material, we should provisionally call the described form from Hokkaido *Mesopuzosia* aff. *chivensis* (Arkhanguelsky).

Occurrence:—The better preserved specimen was found by H. Kokubun at loc. R2243 of the Obira area, together with *Yubariceras yubarense* Matsumoto, Saito et Fukada, which indicates

the Middle Turonian. The other specimen stored at IGPS., without locality record, is inferred to have come from somewhere in Hokkaido or South Sakhalin.

Mesopuzosia yubarensis (Jimbo)

(By T. Matsumoto, Y. Kawashita and T. Takahashi)

Figures 21—24, 25F, 26—27

1894. *Desmoceras yubarense* Jimbo, p. 28 (174), pl. 1 (17), fig. 6, 6a, 6b.
1954b. *Mesopuzosia yubarense* (Jimbo) (sic.); Matsumoto, p. 86, pl. 13, figs. 3, 4; pl. 14, figs. 2, 3.
1963. *Mesopuzosia yubarensis* (Jimbo); Matsumoto, p. 43, pl. 60, fig. 6.
?1965a. *Mesopuzosia yubarensis* Jimbo; Collignon, p. 4, pl. 377, fig. 1637.

Holotype:—UMUT. MM 7508 (=GT. I-97), from a pebble of the River Yubari (Coll. K. Jimbo).

Material:—In addition to the specimens dealt with in 1954, there are now numerous specimens in subsequent collections by several friends of mine and also those in MCM and GK. The following specimens are examples of microconchs and macroconchs respectively:

Microconchs: YKC. 610712, obtained by Y. Kawashita from the Karasemi-zawa of the Naka-no-futamata-gawa, a tributary to the River Haboro (Fig. 23); GK. H8089 (Fig. 21), from loc. IA309 and GK. H8090 (Fig. 22) from loc. IA298p, both Tomiuchi (=Hetonai) area (A. Inoma Coll.); GK. H8092 and GK. H8107 from loc. Ik. 1350, Yoshiachi-zawa, Ikushumbets area (T. M. Coll.).

Macroconchs: TTC. 450421 obtained by T. Takahashi from loc. Ik 2708 (Zone of *Inoceramus mihoensis*) of the Pombets-Gono-sawa (Mikasa) (Fig. 26); YKC. 570621, obtained by Y. Kawashita from the Karasemi-zawa (Haboro) (Fig. 24); huge specimen obtained by Tadashi Hashimoto from loc. Ik 8304 (Zone of *I. uwajimensis*), Oku-hidarimata-zawa, the upper reaches of the River Ikushumbets (Fig. 27).

Diagnosis:—Whorls in the main growth-stage considerably compressed (B/H = 0.60 to 0.69 in many cases), longish suboval in section, with narrowly arched venter. Involution nearly or somewhat less than a half. Rate of whorl expansion moderate but sometimes higher. Umbilicus of moderate width, surrounded by low but vertical wall and subrounded shoulder.

Ribs numerous, dense and fine, sharp-headed on shell surface, mostly long with some intercalated shorter ones; very gently sigmoidal or nearly radial on the main part of flank, curved forward on outer flank and markedly projected on the venter.

Periodic constrictions and flares narrow and more or less frequent, running in parallel with the long ribs.

Microconch of moderate size at the adult stage. Ribs and constrictions or flares persist to the body-chamber, increasing gently and slightly in their intensity and coarseness.

Macroconch very large or huge; five or more times as large as microconch in diameter. Ribs weaken gradually and constrictions shallow in the late part of the phragmocone, where blunt major radial elevations begin to appear on inner flank. Body-chamber smooth on surface, but for subradial major elevations, which arise above the umbilical shoulder at wide intervals (at each 30° on the average) with variable strength and broaden but lower outward. The body-chamber may broaden with inflated flanks especially on radial buldges and the venter may be more broadly rounded than that of the phragmocone.

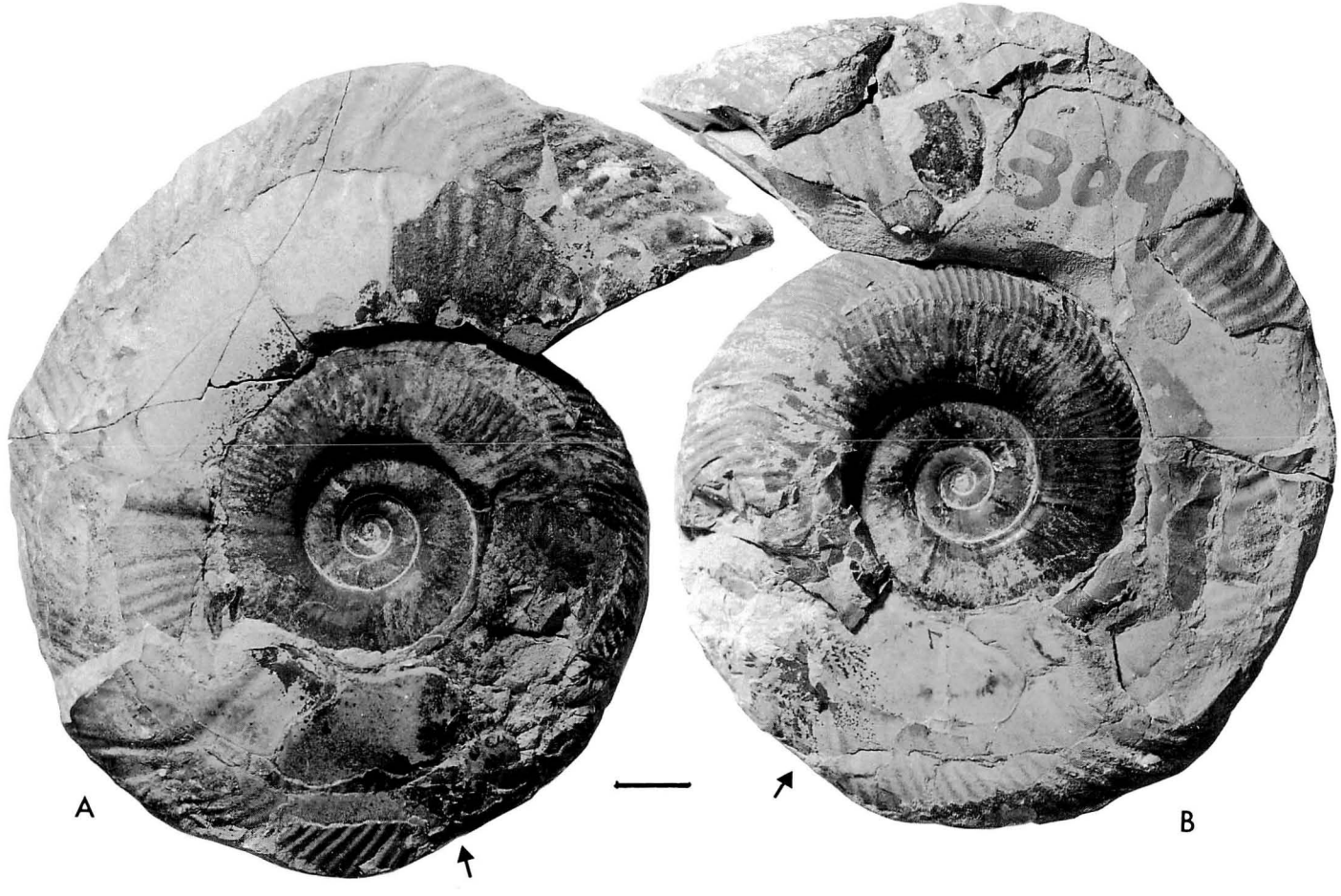


Figure 21. *Mesopuzosia yubarensis* (Jimbo).
A—B: microconch, GK. H8089 from loc. IA 309, Hetonai (Coll. and donated by A. Inoma). The body-chamber is deformed but preserves the muscle impressions at its bottom. Bar = 10 mm.

Sutures on the outer whorl very finely and deeply incised and, accordingly, extremely florid, but fundamentally of *Puzosia* pattern.

Dimensions:—

Specimen	D	U	H	B	B/H	H/h	R/r
Holotype	42.1 (1)	11.0 (.26)	18.8 (.45)	12.9 (.31)	0.69	—	—
UMUT. MM	81.0 (1)	25.5 (.31)	34.0 (.42)	22.0 (.27)	0.65	1.55	—
GK. H8089	*c.* 111.0 (1)	*c.* 39.0 (.35)	*c.* 42.5 (.38)	— (secondarily compressed)			
〃 (septate)	*c.* 68.0 (1)	24.0 (.35)	26.8 (.39)	18.6 (.27)	0.69	—	—
GK. H8090 (body-chamber)			50.0	31.0	0.62		
YKC. 610712	119.0 (1)	38.0 (.32)	46.0 (.39)	—	—	1.31	1.50
〃 (−180°)	*c.* 85.0 (1)	26.5 (.31)	35.0 (.41)	23.0 (.27)	0.66	—	—
TTC 450421	192.0 (1)	63.0 (.33)	*c.* 77.0 (.40)	— (secondarily compressed)			
〃 (−180°)	*c.* 131.0 (1)	41.5 (.32)	54.0 (.41)	38.0 (.29)	0.70	1.43	—
YKC. 570621	310.0 (1)	93.0 (.30)	131.0 (.42)	*c.* 76 (.25)	0.58	1.56	—
Hashimoto's	964.0 (1)	290.0 (.32)	352.0 (.39)	*c.* 310 (.32)	0.88	1.34	—

Observations:—The microconch body-chamber of this species is often distorted or destroyed secondarily and the complete specimen with the apertural margin preserved has not yet been obtained. In GK. H8089 (Fig. 21) the body-chamber is as long as 240° and may be nearly complete, though deformed secondarily, but its very apertural margin is regrettably missing. GK. H8090

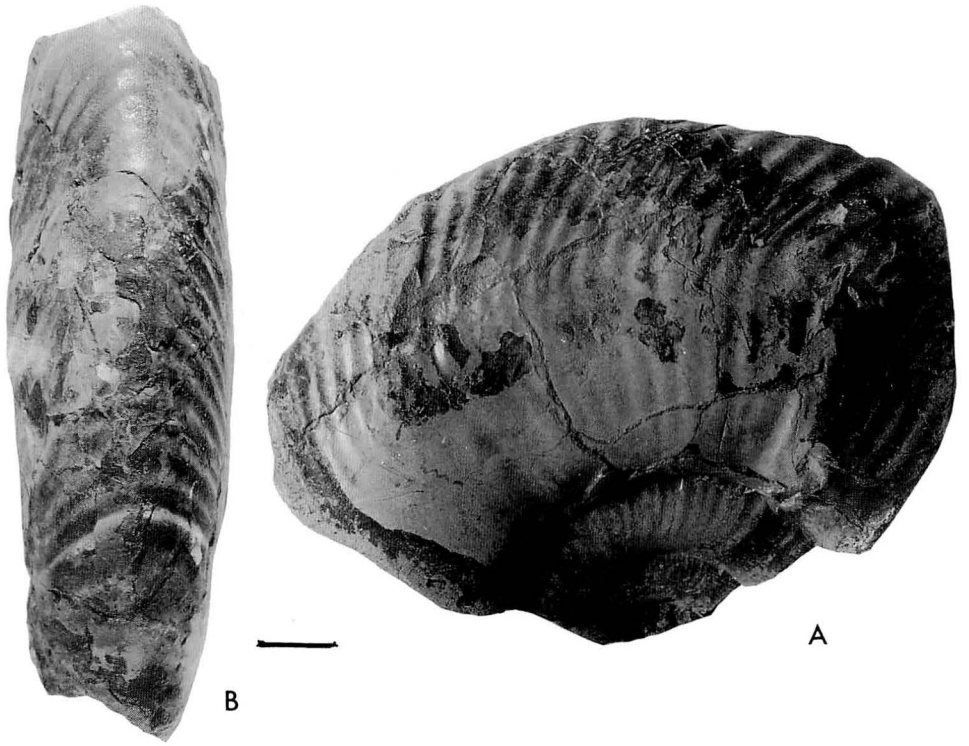


Figure 22. *Mesopuzosia yubarensis* (Jimbo)
A—B: microconch, GK. H8090 from loc. IA 298p, Hetonai (Coll. and donated by A. Inoma). Fragmentary but less deformed body-chamber and overlapped inner whorls. Bar = 10 mm.

has a nearly undeformed body-chamber, showing B/H = 0.62, but it is incomplete. It must have been originally as large as YKC. 610712, although the body-chamber of the latter is incomplete at the last part. The restored shell diameter of these specimens would be about 120 to 130 mm, and this may be the approximate size of the microconch. There could be, however, some extent of variation in size.

Incidentally, the impressions of muscle attachments are preserved on the internal mould at the bottom of the body-chamber on both sides of GK. H8089 (see Fig. 21).

The ribs are so fine in this species that they may be very weakly or scarcely discernible on the internal mould. When the preservation is favourable, however, fine long ribs are seen even in fairly early growth-stage. This, as well as the characteristic shell-form, has enabled us to redefine this species, although the holotype is a small, immature shell.

The macroconch represented by T. Hashimoto's huge specimen (Fig. 27) might be regarded

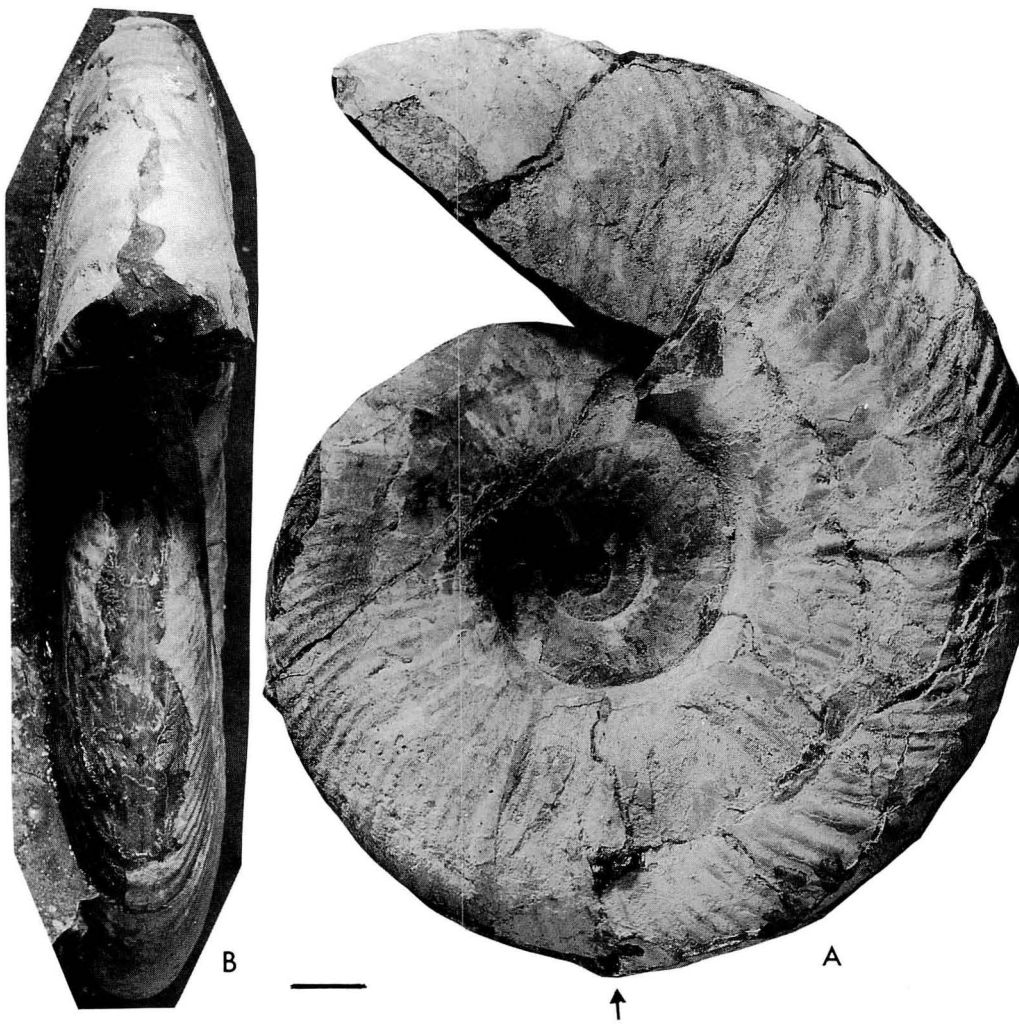


Figure 23. *Mesopuzosia yubarensis* (Jimbo)
A—B: microconch, YKC. 610712 from the Karasemi-zawa, Haboro area (Coll. Y. Kawashita); bar = 10 mm.

as a *Pachydesmoceras* by someone, because of the inflated outer whorl with broad major ribs. T.M. and Y.K. investigated, together with M. Noda, its original locality, Ik 8304 (M in Fig. 86). With the kind help of K. Kato and J. Mitsunushi, several large shells of similar characters came out there but their inner whorls or smaller specimens are always compressed, showing the diagnostic characters of *M. yubarensis*. The inner whorl of Hashimoto's specimen itself is not so broad as the outer one. For these reasons we regard this specimen as a macroconch of *M. yubarensis*. Furthermore, there are some specimens (e.g. TTC. 450421 and YKC. 570621) which represent late middle aged part of the macroconch, showing the characters quite similar to those of the microconch of *M. yubarensis*. YKC. 570621 is nearly wholly septate and the last suture is in its preserved last part. The restored diameter at the last suture may be about 380 (or 400) mm and that at the end of the missing body-chamber can be estimated at 630 mm or so. (This matches the average size of several macroconch examples from the Futaba Group of Northeast Japan, which should be described on another occasion.)

The huge specimen of T. Hashimoto has the last suture at about 830 mm in diameter and the major radial elevations begin to appear at the stage about a half whorl earlier than the end

Figure 24. *Mesopuzosia yubarensis* (Jimbo)
Macroconch, YKC. 570612 from the Karasemi-zawa (Coll. Y. Kawashita); mostly internal mould showing finely and deeply incized sutures, with ribbing in a portion where shell layer is preserved; phragmocone for the major part, with a fraction of the beginning of body-chamber at the preserved end; scale bar = 30 mm. See Fig. 25F for the whorl-section at Q in this figure.

of the phragmocone. The body-chamber is preserved for about 120° in this specimen. As the major radial elevation is going to weaken at the preserved end, the missing later part of the body-chamber may have been nearly smooth with only weak undulations. Anyhow, its shell diameter is estimated to be at least 1300 mm at the end of a restored outline. This should be called an unusual giant event for this species.

Comparison and discussion:—This species is distinct from *M. pacifica* in its much compressed

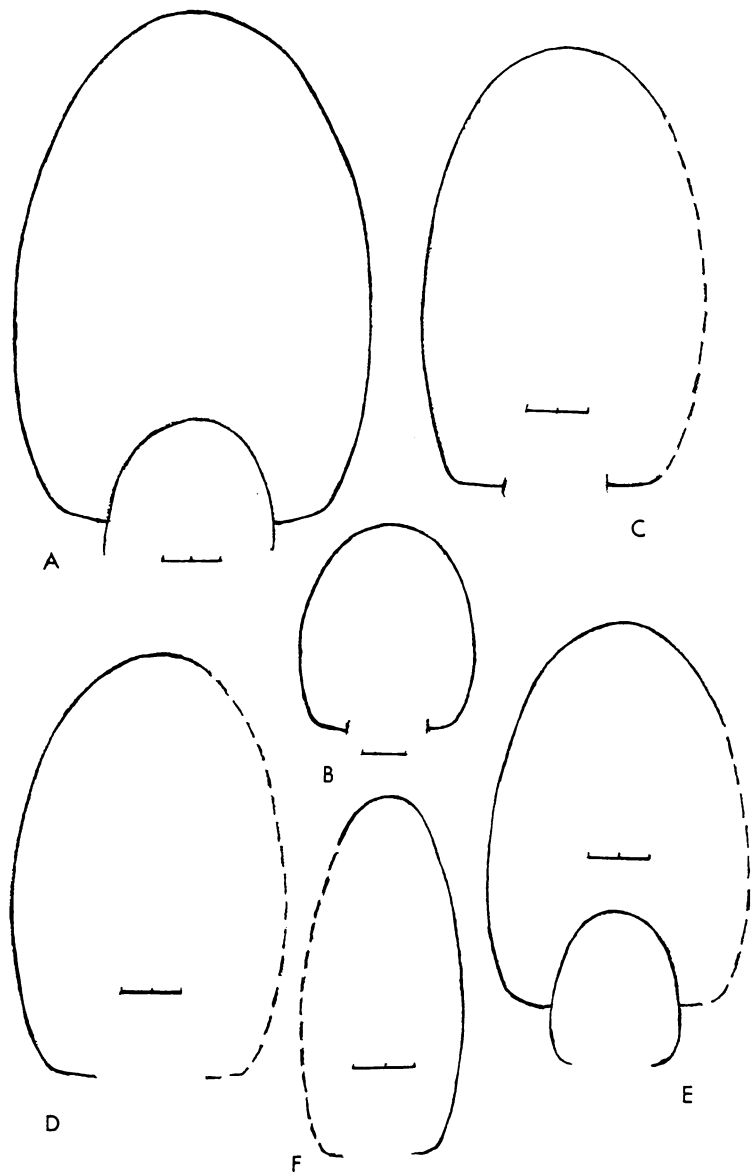


Figure 25. Whorl-sections of *Puzosia* and *Mesopuzosia*.
A: P. orientalis (at LS in Fig. 6A); B: *M. pacifica,* microconch (at Q in Fig. 9A); C: *M. pacifica,* macroconch (at Q in Fig. 10A); D: *M. pacifica* macroconch (at Q in Fig. 11); E: *M. takahashii,* macroconch (at Q in Fig. 12); F: *M. yubarensis,* macroconch (at Q in Fig. 24). Scale bar = 20 mm except for B (bar = 10 mm). (T. Matsumoto *delin.*)

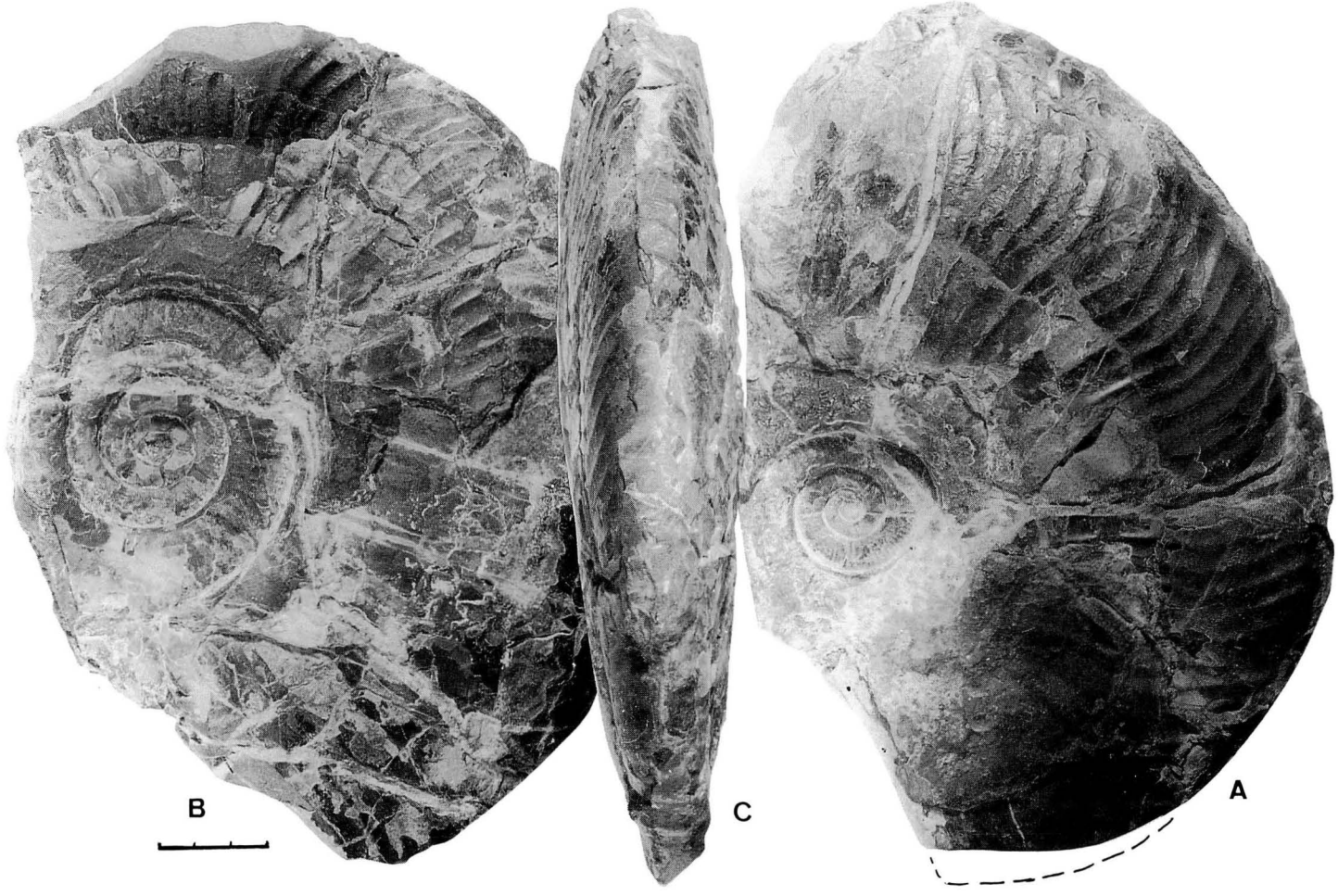


Figure 26. *Mesopuzosia yubarensis* (Jimbo).
A—C: probably middle-aged macroconch, TTC. 450421 from loc. Ik 2708, Zone of *Inoceramus mihoensis,* Pombets-Go-no-sawa, Ikushumbets Valley (Coll. T. Takahashi); body-chamber of outer whorl secondarily compressed. Scale bar = 30 mm;

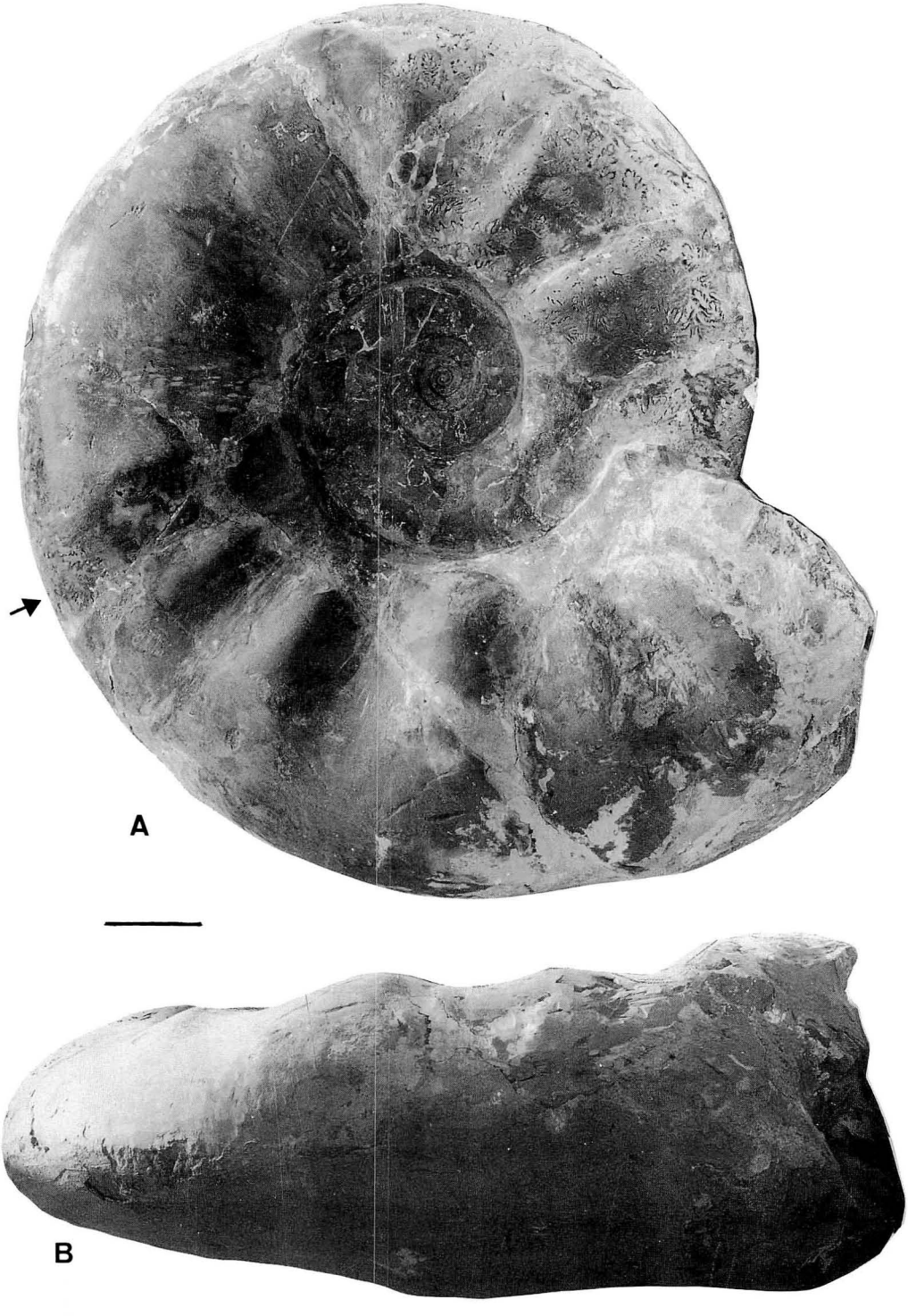


Figure 27. *Mesopuzosia yubarensis* (Jimbo).
A—B: huge macroconch, T. Hashimoto Coll., from loc. Ik 8304 (M in Figure 86), Oku-hidarimata-zawa, upper reaches of the River Ikushumbets, Zone of *Inoceramus uwajimensis*. Bar = 100 mm.

whorl and denser, more numerous, finer and less flexuous ribs which show more pronounced projection on outer part.

M. yubarensis differs from *M. takahashii* in its less involution, lower ratio of whorl-expansion, broader umbilicus, more compressed whorl in the middle growth-stage, finer ribs and flares with markedly forward bend on outer flank.

As I mentioned previously (Matsumoto, 1954b, p. 85), *M. yubarensis* may be allied to *Puzosia orientalis*. This is suggested by fine and numerous ribbing and also somewhat similar shell-form, but in the former ribs are predominantly longer, arising from the umbilical rim, and show more distinct projection on outer part, and also the whorl is more compressed than in the latter.

The above distinctions are concerned mainly with the microconch and the phragmocone of macroconch. With respect to the body-chamber of macroconch, these distinctly different species may be apparently similar to each other in the broadened whorl with somewhat inflated flanks and the development of major radial undulations.

M. yubarensis described by Collignon (1965a, p. 4, pl. 377, fig. 1637) from the upper Turonian of Madagascar may be within the extent of variation, but it is not quite identical with the typical form from Hokkaido in its somewhat larger ratio B/H = 0.76 and less narrowly arched venter.

M. yubarensis described by Howarth (1966a, p. 221, pl. 2, figs. 1, 2) from the "mid-Turonian" of the Mocamedes desert, Angola, is not the named species but probably an inner whorl of a species of *Pachydesmoceras* allied to *P. kossmati* Matsumoto described in p. 116. Howarth complained of too few specimens from Hokkaido which were dealt with in 1954, but now there are sufficient number of specimens which show the diagnostic characters described above, without so wide extent of variation as Howarth claimed (e.g. B/H in Howarth's specimen is 0.87, but no example of *M. yubarensis* shows such a large ratio except for the macroconch body-chamber.)

Occurrence:—This species occurs abundantly in the Coniacian Zones of *Inoceramus uwajimensis* and *I. mikoensis* of various areas in Hokkaido, especially in the muddy sediments exposed in the valleys Ashibetsu, Ikushumbets, Yubari and Mukawa Rivers of the Yubari Mountains. Several friends of ours in Hokkaido have shown us numerous (10 or more) microconchs contained roughly in parallel orientation within each of nodules from various areas in Hokkaido. Large macroconchs are often embedded in the same unit of strata, although it is difficult to obtain a complete specimen.

The species occurs sometimes in the Upper Turonian *Zone* of *I. teshioensis,* as exemplified by the illustrated ones from the Haboro area of the Teshio Mountains.

Mesopuzosia indopacifica (Kossmat)

(By T. Matsumoto and Y. Kera)

Figures 28—30

1898. *Puzosia indopacifica* Kossmat, p. 117 (182), pl. 17 (23), fig. 2; pl. 18 (24), fig. 3.
1954b. *Mesopuzosia indopacifica* (Kossmat); Matsumoto, p. 84.
1959b. *Mesopuzosia indopacifica* (Kossmat); Matsumoto, p. 19.
1968. *Mesopuzosia indopacifica* (Kossmat); Sastry *et al.*, p. 14, pl. 3, figs. 1—2.

Holotype:—A single specimen described and illustrated by Kossmat (1898) (see above list).

Material:—GK. H1248a (Fig. 28) and H1248b from loc. Y207p2, GK. H1247 from loc. Y207p1 and GK. H1251 from loc. Y466, all T. M. Coll. in the Shiyubari valley (i.e. upper reaches

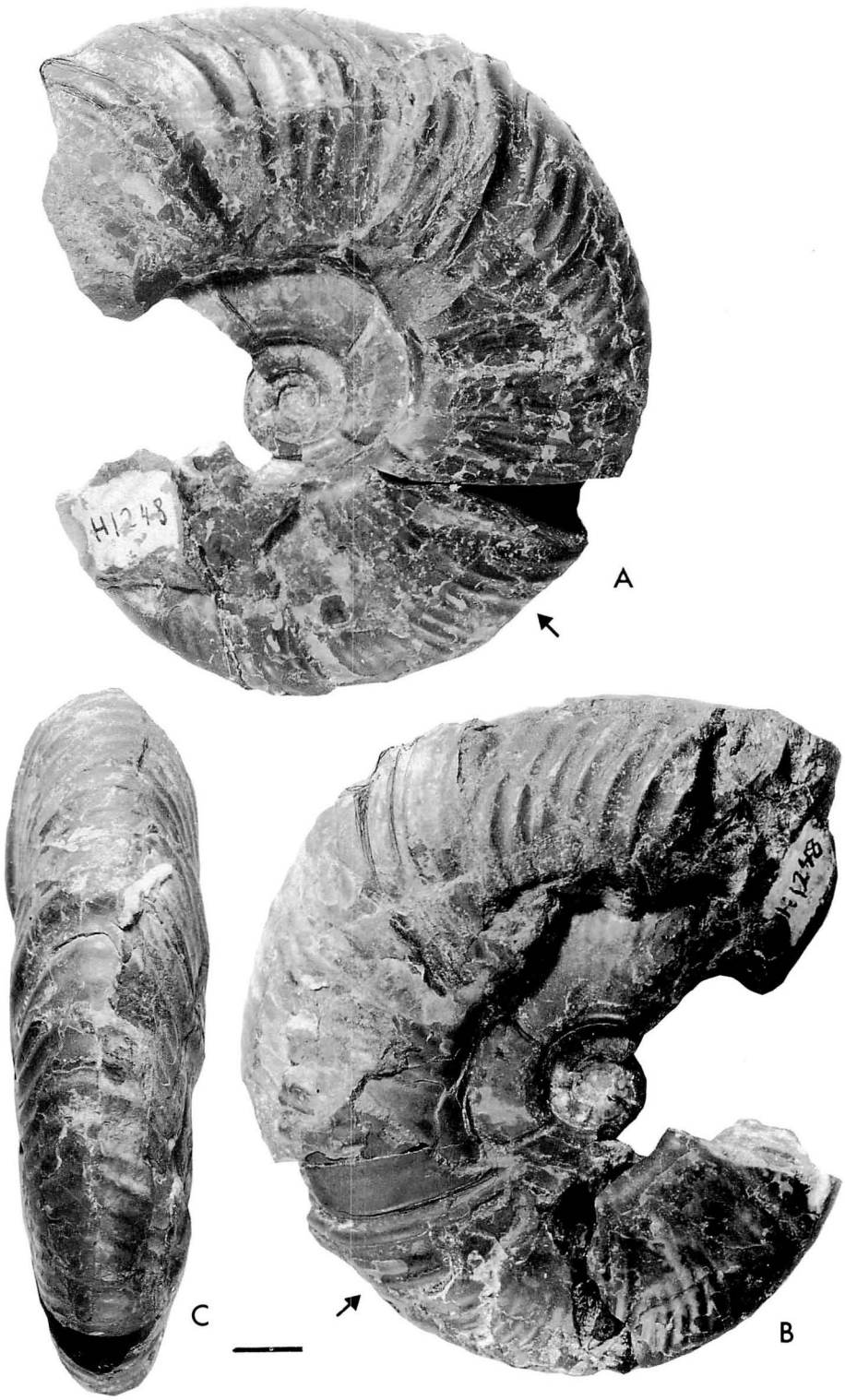


Figure 28. *Mesopuzosia indopacifica* (Kossmat).
A—C: microconch, GK. H1248a from loc. Y207 p2, the Shiyubari Valley (T. Matsumoto Coll.); bar = 10 mm.

of the River Yubari adjacent to the north of Oyubari area); GK. H1572 (Fig. 30), S. Nagao and H. Osanai Coll. from their loc. 107A on the Hakkin-zawa. These are small or medium-sized, but preserve a part of the body-chamber.

Y. Kera Coll. no. 16 (Fig. 29) from loc. Y5203—5204 outcrop on the river floor of the Hakkin-zawa, Oyubari area. This is a comparatively larger example, with incomplete body-chamber for 200°.

Diagnosis:—Rate of whorl-expansion moderate and involution less than a half or about two fifths; width of umbilicus moderate. Whorl somewhat higher than broad, typically with flat and nearly parallel flanks, abruptly bent umbilical shoulder, low but vertical wall and rather narrowly arched venter.

Ribs on middle-aged shell fine and dense; many of them long with some intercalated shorter

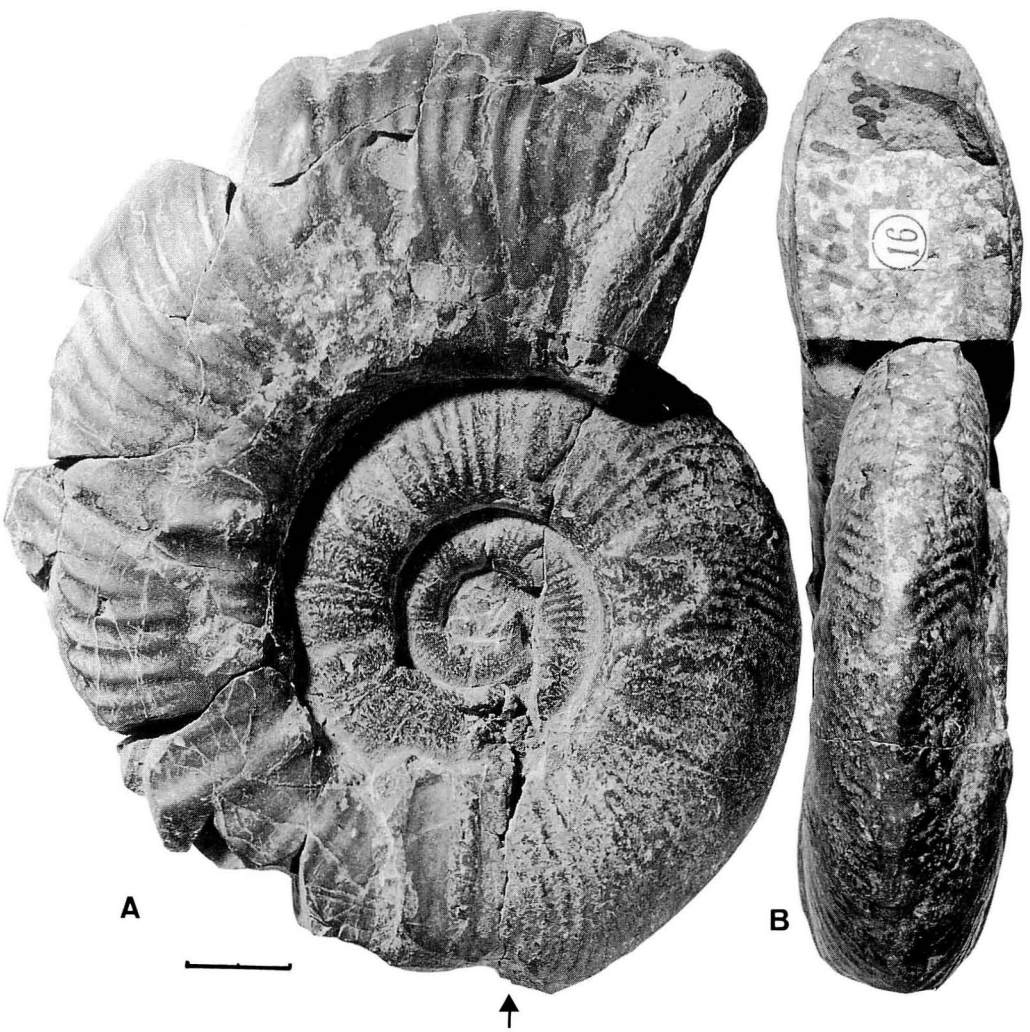
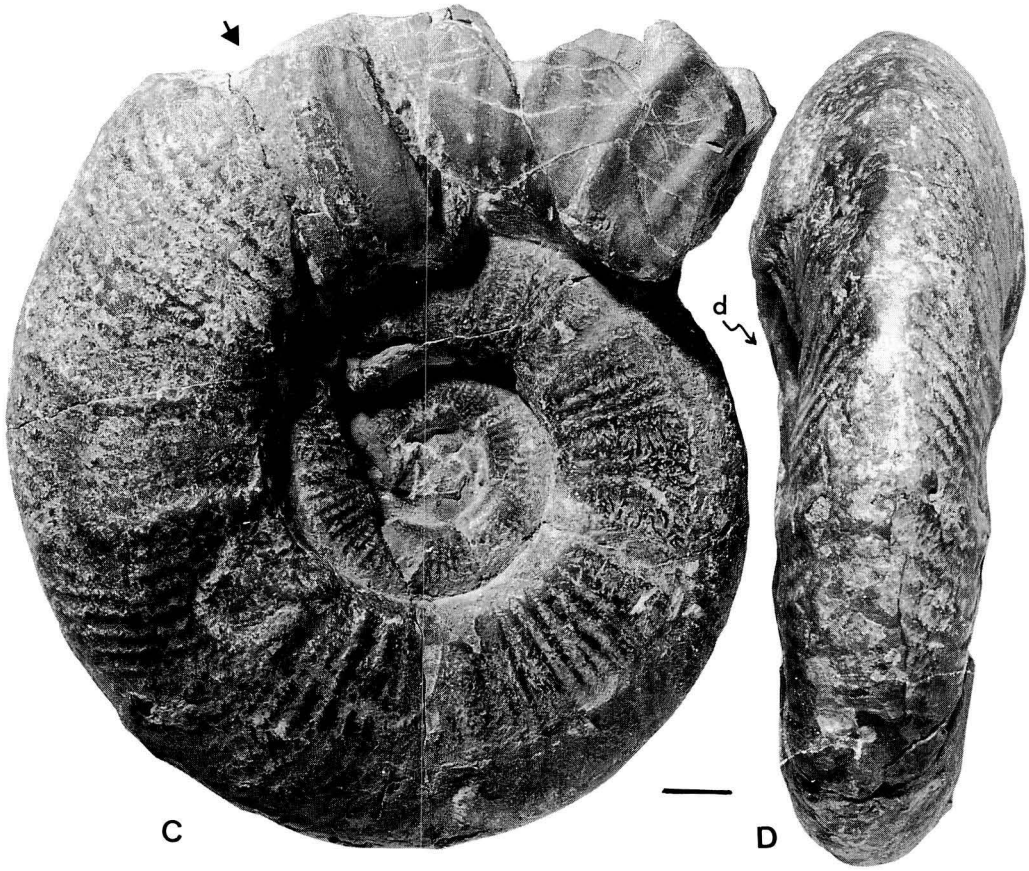


Figure 29. *Mesopuzosia indopacifica* (Kossmat).
A—D: presumably middle-aged macroconch, Y. Kera Coll. no. 16 from loc. Y5203, Hakkin-for the major part, with a portion damaged (marked d in Fig. 29D); bar = 10 mm.

ones; some of them gently sigmoid and others prorsiradiate on the main part of the flank; all the ribs curved moderately forward on the outer flank, crossing the venter with projection. Constrictions on the phragmocone moderate in depth and frequency (5 to 6 per whorl), rather narrow, somewhat prorsiradiate and gradually curved forward on the outer part; they may accompany narrow flare in the late middle growth-stage.

In the adult shell, mainly on the body-chamber, the ribs are moderately strong, with gradual but rather rapid coasening from the late septate stage, nearly radial on the inner flank and typically bent abruptly forward on outer flank, showing marked projection on the venter. Flares on the body-chamber frequent, strong, prorsiradiate on the main part of the flank and projected markedly on the outer part; they may accompany shallow constrictions.

Microconch of moderate size. Possible but yet doubtful macroconch nearly twice as large as microconch.



zawa, Oyubari area. A— B: entire shell, with deficient body-chamber; scale bar = 20 mm; C—D: phragmocone

Dimensions:—

Specimen	D	U	H	B	B/H	H/h	R/r
Holotype	115.0 (1)	41.0 (.36)	44.5 (.39)	33.0 (.29)	0.74	1.46	1.42
GK. H1248a	96.3 (a)	29.4 (.31)	39.2 (.41)	26.6 (.28)	0.68	1.40	—
〃 −180°	—	—	27.7	20.0	0.72	—	—
GK. H1572	82.0 (1)	26.5 (.32)	33.6 (.41)	24.0 (.29)	0.71	1.47	—
Kera 16	186.0 (1)	73.0 (.39)	69.0 (.37)	44.0 (.24)	0.64	1.51	1.43
〃 −180°	126.5 (1)	46.0 (.36)	45.5 (.36)	35.5 (.28)	0.78	1.34	—

Observations:—The holotype itself is distinctive and was clearly described by Kossmat (1898). It is, however, incomplete in that it preserves about a half of the body-chamber and that it does not show the apertural margin. On its preserved part of the body-chamber the ribs are stronger and more projected than those of the phragmocone. Therefore, it certainly represents an adult microconch. The diameter of the entire shell, with the missing half of the body-chamber restored, would be about 125 mm.

Regrettably, the holotype is a single available specimen of this species from the Trichinopoly Group of South India and the extent of variation in the population of India is not known. *P. indopacifica* from Madagascar described by Collignon (1932) is not this species, as Matsumoto has mentioned already (p. 10).

Several examples of the microconch from Hokkaido are mostly from the upper part of the Saku Formation in the Shiyubari valley. One of them, GK. H1248a (Fig. 28) is similar to the holotype, although the body-chamber is somewhat deformed secondarily. In this specimen the flat, parallel flanks begin to appear in its early middle aged whorl and its smaller inner whorl has gently convex flanks. In some others the gently convex flanks persist to the middle aged whorl. In GK. H1572 (Fig. 30), even the late part of the phragmocone has gently convex flanks and compressed subelliptical in cross-section, although its crushed body-chamber may have been flat sided. These facts imply that there is variation within this species as to the stage when the flat, parallel flanks appear. Likewise there may be some variation as to the stage at which the prorsiradiate and markedly forward bent ribs begin to be characteristic or upto which some ribs remain to be gently sigmoidal.

In Kera no. 16 (Fig. 29) the phragmocone ends at D = 127 mm and is followed by the incompletely preserved body-chamber for about 200°. Should its body-chamber assumed as long as 240°, then its entire shell diameter would be 217 mm. Anyhow, it is distinctly larger than the holotype from India and other examples from Hokkaido. Therefore it may represent a macroconch of this species, but it is different from the usual macroconchs of other species of *Mesopuzosia* in that its body-chamber is not smoothed and not inflated but compressed and has numerous ribs instead of major radial undulations. This can be interpreted in two ways. One is that this specimen is still a middle-aged shell of a macroconch and that the adult macroconch would be much larger, presumably three or four times as large as the microconch. The other is that this specimen is mature and that the macroconch of *M. indopacifica* differs considerably from that of other *Mesopuzosia* species. There could be quite different, third interpretation to regard this specimen as a large microconch, probably a variety of *M. indopacifica*. Therefore, we call this specimen provisionally a possible but doubtful macroconch. To sum up, we should search for more material to know the true state.

In Kera no. 16 the phragmocone has still gently convex flanks and subovoid section with subrounded umbilical shoulder, but the mode of ribbing is generally similar to that of the

phragmocone of microconchs, except that a few major ribs of *Parapuzosia* type appear indistinctly on its late part. The last mentioned ornament does not continue to develop further. On the body-chamber the ribs are somewhat coarser, nearly radial on inner flank and bent fairly abruptly forward on outer part, although on the preserved last part the bending looks to be gradual. The flares on the body-chamber are frequent, thick and prorsiradiate or concave. This is quite different from the macroconch body-chamber of other species in which the ribs and flares disappear and are replaced by major radial undulation. Furthermore, the body-chamber of this specimen is compressed and roughly parallel sided and does not tend to be inflated. Taking these points into consideration, we cannot deny the third interpretation mentioned above.

Comparison and discussion:—The affinity of this species is not clearly known, but *M. indopacifica* has common characters with *M. yubarensis,* if minor details are ignored. In both species the whorl is comparatively more compressed and less involute than that of other species of the same genus and the ribs are markedly projected on the outer part of the whorl. In fact in the early growth-stage, *M. indopacifica* is similar to *M. yubarensis.* In more or less later stages the former has flat, nearly parallel flanks and fairly coarser and stronger ribs with loss of gently sigmoid curvature, whereas the latter, except for the body-chamber of macroconch, has generally more compressed whorl but gently convex flanks, finer and denser ribs with some gently sigmoid ribs persistent, and also narrower and weaker flares.

The nearly flat and parallel sided, compressed whorl is not confined to *M. indopacifica* but occurs also in certain species of *Puzosia,* e.g. *P. compressa* Kossmat. Taking other characters

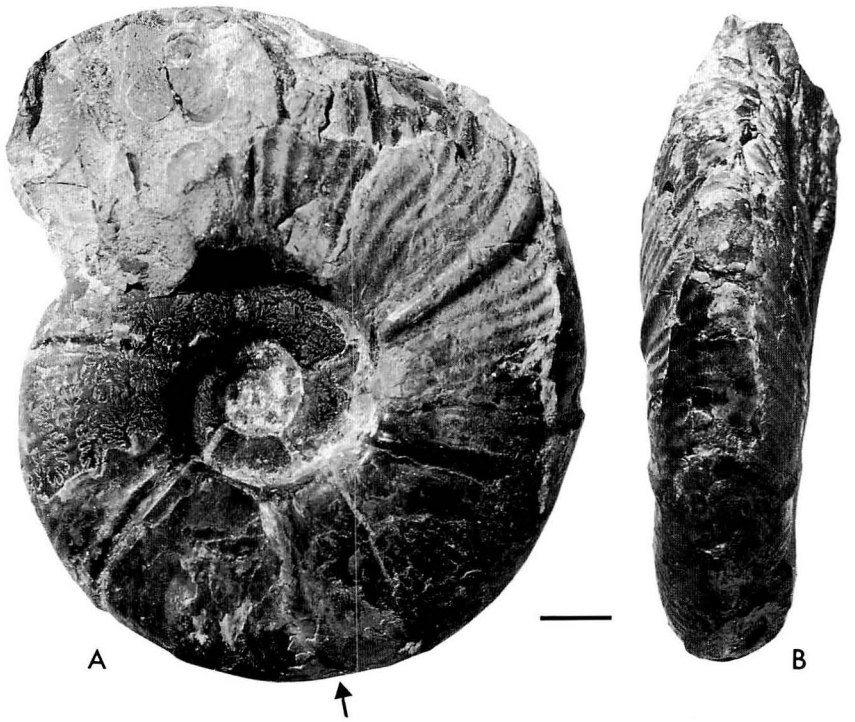


Figure 30. *Mesopuzosia indopacifica* (Kossmat).
A—B: microconch, GK. H1572 from loc. 107A of S. Nagao, Hakkin-zawa, Oyubari area (Coll. and donated to GK. by S. Nagao & H. Osanai); bar = 10 mm.

into consideration, we do not interpret that kind of *Puzosia* as ancestral to *M. indopacifica.*

If the affinity of *M. indopacifica* with *M. yubarensis* is warranted and if the suggestion that *Puzosia orientalis* could be ancestral to *M. yubarensis* were supported on sufficient evidence, then *M. indopacifica* could be interpreted as a branch from some point on the line of descent *P. orientalis-M. yubarensis,* acquiring parallel sided shell-form and coarser and non-sigmoid, projected ribs and flares in the late growth-stage. These characters could be interpreted as a tendency towards more distinctive characters of *Neopuzosia* and *Kitchinites.*

If the affinity of *M. indopacifica* with a certain species of *Neopuzosia* were warranted, then the particular characters of the possible but doubtful macroconch mentioned above would become reasonable, for they are similar, if not identical, to those of the macroconch of *Neopuzosia japonica* (Spath). In the present state of our knowledge, this is merely a suggestion or rather a working hypothesis and should be worked out by further search for sufficient evidence.

Occurrence:—The record of the occurrences of this species in various areas of Hokkaido is yet incomplete, As far as the Shiyubari-Oyubari area of the Yubari Mountains is concerned. *M. indopacifica* occurs in the Middle and Upper Turonian.

In South India this species ranges from the Middle Turonian to the Coniacian (Kossmat, 1898; Sastry *et al.*, 1968).

Genus *Neopuzosia* Matsumoto, 1954

Neopuzosia japonica (Spath)

(By T. Matsumoto)

Figures 31A—B, C—F; 32A; 33A—C

1890. *Desmoceras gaudama* Forbes; Yokoyama, p. 184, pl. 19, figs. 5a, b; (?) pl. 18, fig. 14.
1922. *Kitchinites japonicus* Spath, p. 127.
1927. *Puzosia japonica* Yabe, p. 45, pl. 6, figs. 3a, b.
1954. *Neopuzosia japonica* (Spath); Matsumoto (1954b), p. 91, pl. 17, figs. 1a, b, 2a, b; pl. 18, figs. 1, 2a, b, 3a, b; pl. 23, figs. 1a—c, 3; text-fig. 4.
1963. *Neopuzosia japonica* (Spath); Matsumoto (*in* Matsumoto ed. 1963), p. 29, pl. 45, figs. 5a, b.

Lectotype:—The larger one of the two specimens illustrated by Yokoyama (1890, pl. 19, figs. 5a, b) under *Desmoceras gaudama,* from Urakawa, Hokkaido (designated by Matsumoto, 1954b, p. 91). It is not kept in the University of Tokyo, for Yokoyama left the specimens described in his 1890 paper in Munich (München) or possibly Berlin.

Material:—Some of the specimens listed in p. 91 of my previous paper (1954b) are reexamined in the light of a guiding principle written in Part I, e.g., GK. H3350 (Fig. 31C—F) from loc. U600b and GK. H3362 (Figs. 31A—B, 32A) from loc. U141 p5, both Urakawa area (Coll. T. Matsumoto). A few other specimens in subsequent collections are also investigated, e.g. GK. H8087 (Fig. 33A—C) from the Upper Coniacian of the upper reaches of the River Naka-kinembets, Obira area, obtained and donated to Kyushu University by A. Tomita.

Diagnosis:—Shell of moderate size: macroconch about 115 to 125 mm in diameter and microconch about two thirds to three fifth of that size.

Discoidal shell with moderate rate of expansion and moderate involution of whorl; umbilicus of moderate width, encircled by low but steep, nearly vertical wall and subrounded umbilical

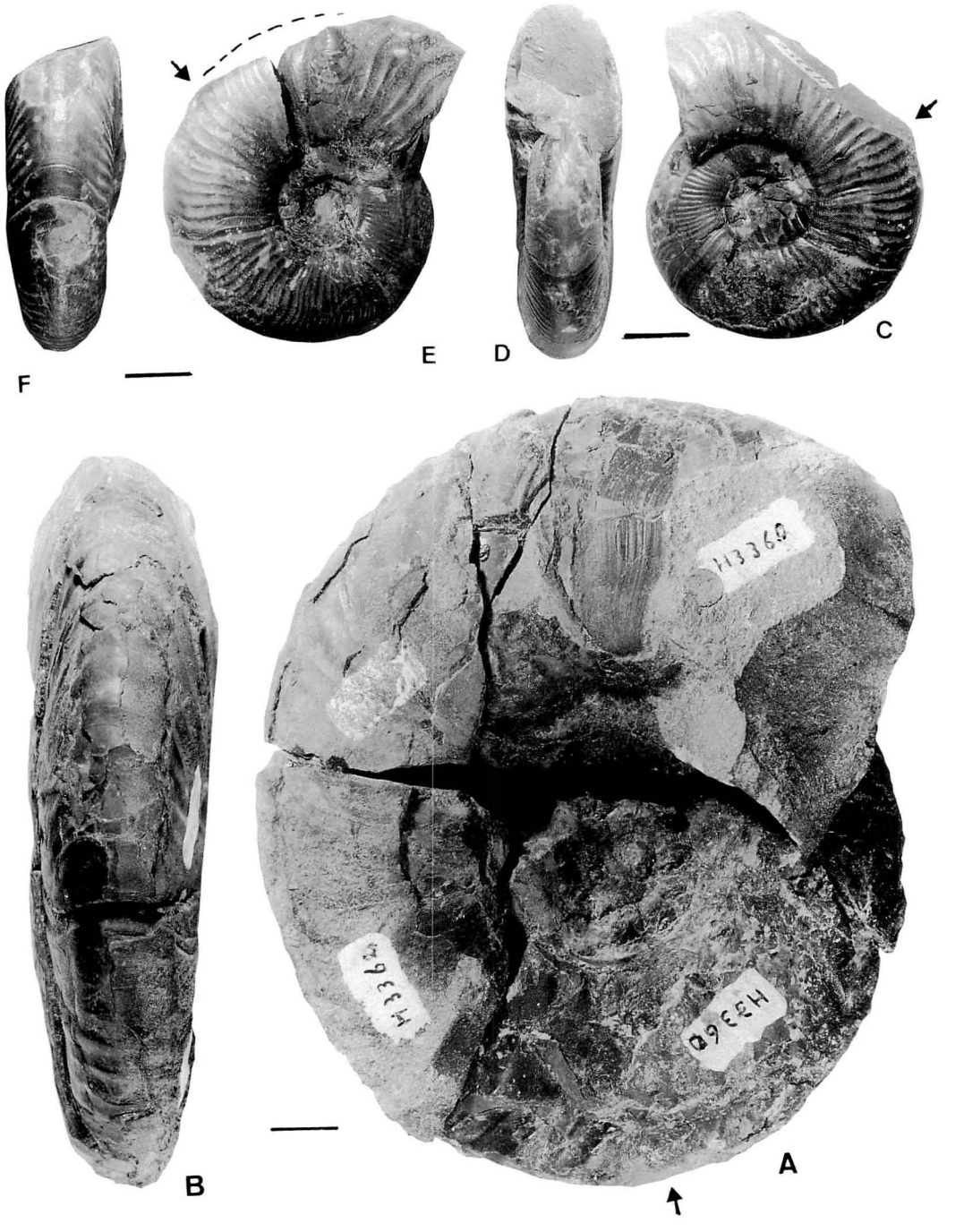


Figure 31. *Neopuzosia japonica* (Spath).
A—B: macroconch, GK. H3362 from loc. U141 p5, Urakawa area (Coll. T. Matsumoto), showing the apertural margin; C—F: microconch, GK. H3350 from loc. U600b, Ikandai, Urakawa area (Coll. T. Matsumoto). All figures natural size; scale bar = 10 mm.

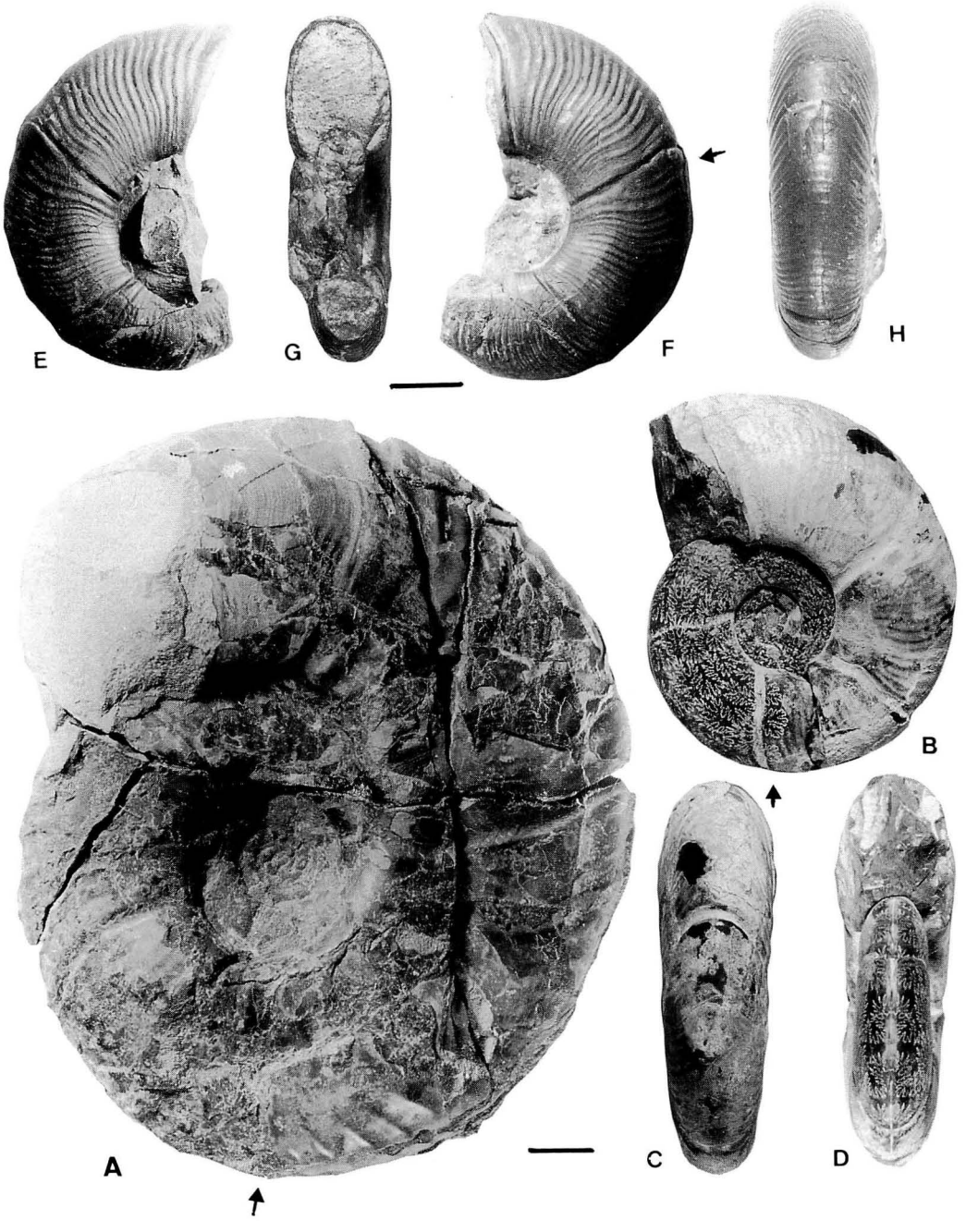


Figure 32. A: *Neopuzosia japonica* (Spath), macroconch, GK. H3362, right side of the same specimen as Fig. 31A—B; B—D; *Neopuzosia ishikawai* (Jimbo), microconch, GK. H5664 from loc. CK 114, Haboro area (Coll. Y. Ueda); E—H: *N. ishikawai,* microconch, GK. H3366 from loc. U512 r4, Urakawa area (Coll. T. Matsumoto). A—D slightly reduced; E—H natural size; scale bar = 10 mm.

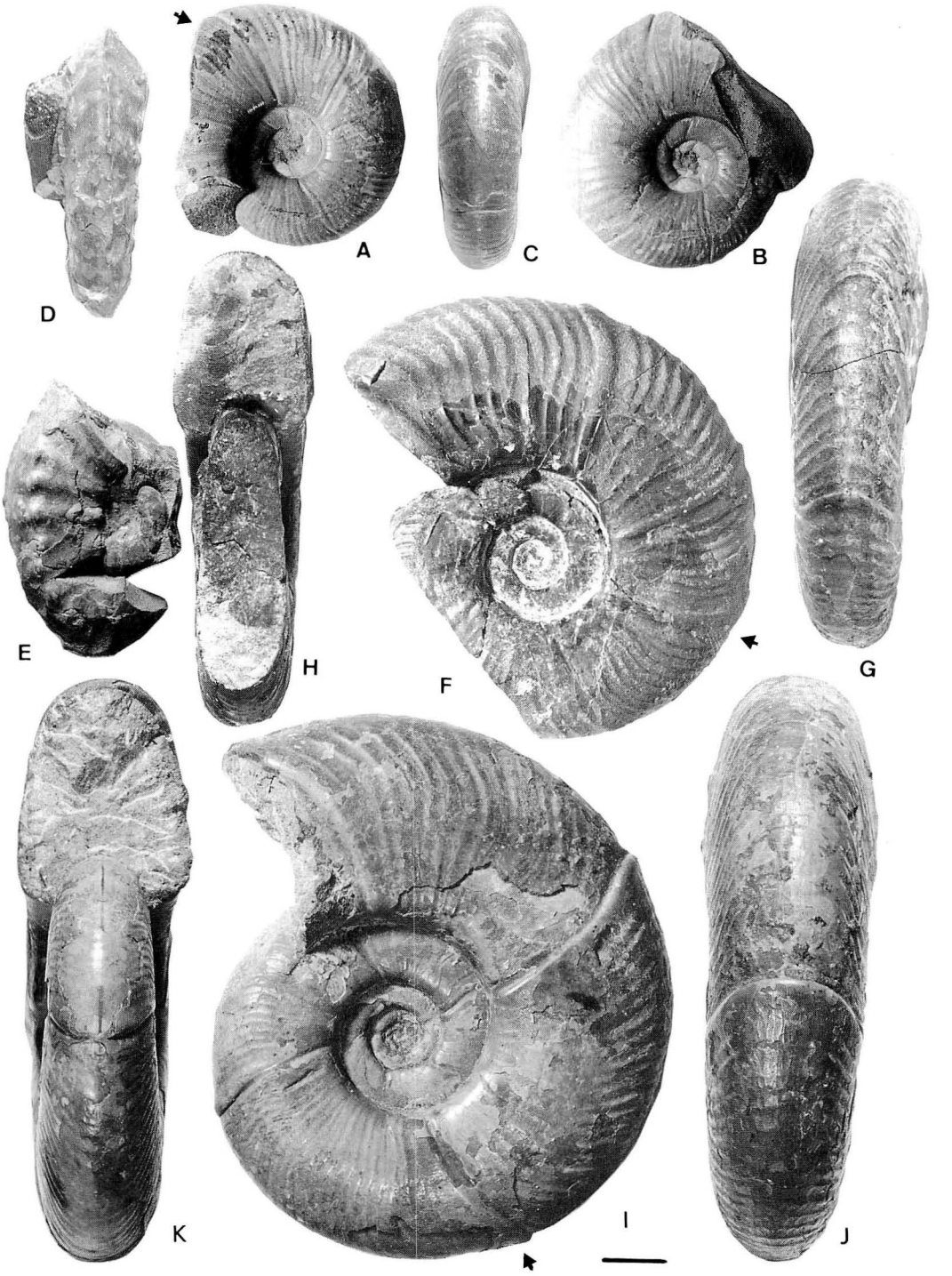


Figure 33. A—C: *Neopuzosia japonica* (Spath), microconch, GK. H8087 from the Obira area (Coll. A. Tomita), showing injured peristome at a middle growth-stage about 90° adaptically from the last septum; D—E: *Gauthiericeras* cf. *margae* (Schlüter), GK. H8088 from the same nodule as GK. H8087; F—H: *Mesopuzosia* aff. *intermedia* (Kossmat), YCM. 712 = T. Suekane Coll. A3 from his loc. K233, Kaneobets, Oyubari area; I—K: *Neopuzosia ishikawai* (Jimbo), microconch, TTC. 510530 from the Deto-futamata-gawa, Haboro area (Coll. T. Takahashi). All figures ×0.9; scale bar = 10 mm.

shoulder. Whorl fairly higher than broad, with rather flat, subparallel flanks in young shell and very gently convex flanks later, with the maximum breadth at a point somewhat dorsad from the mid-height.

Constrictions of moderate or somewhat higher frequency, 5 to 7 per whorl, prorsiradiate with or without slight sinuosity in the main flank and considerably projected on the outer part, being oblique to the ribs behind them in the phragmocone.

Numerous fine ribs crowded on the immature shell, gradually becoming slightly coarser and more distinct as the shell grows. Ribs mostly long, more or less sigmoidal, arising at the umbilical rim, with some intercalated or branched shorter ones which start on the inner flank or near the mid-flank; still shorter ones immediately behind the projected constriction.

On the body-chamber of adult microconch ribs somewhat coarser than those on the phragmocone; some gently sigmoidal and others nearly straightly subradial or prorsiradiate on the main flank, all the ribs projected on the outer part; the obliquity between the constriction and ribs less pronounced or nearly lost on the late part of the body-chamber. The peristome lappeted.

The body-chamber of macroconch ornamented with strong and long, nearly straight or gently arcuate (concave) ribs which are nearly parallel to the periodic flares or constrictions. The ribs thicken and strengthen on the outer part, with occasionally intercalated short but similarly strong ones, and cross the venter with some projection.

The marginal zone at the end of the body-chamber, about 25° to 30° in spiral length, in front of the last flare nearly smooth, only with fine lirae on the whole surface and weak riblets on the ventral part; its peristome provided with a considerably projected rostrum on venter and slightly sinuous on side.

Dimensions:—

Specimen	D	U	H	B	B/H	H/h	Inv
Lectotype (fig.)	94.5	29.5 (.31)	39.5 (.42)	24.5 (.26)	0.62	1.55	0.50
BM. C47735	93.0	28.3 (.30)	40.0 (.43)	25.0 (.27)	0.63	1.60	0.53
GK. H5143 (LS)	79.0	27.2 (.34)	31.5 (.40)	21.1 (.27)	0.67	1.55	—
" LS + 200°	125.0	37.5 (.30)	51.8 (.41)	34.0 (.27)	0.66	1.45	—
GK. H3350 (LS+90)	51.8	16.6 (.32)	21.0 (.41)	16.2 (.31)	0.77	1.48	0.45
GK. H8087 (LS?)	40.0	11.2 (.28)	18.0 (.45)	13.5 (.34)	0.75	1.40	0.52
N. ishikawai for comparison							
UMUT. MM 7502	38.5	12.0 (.31)	16.5 (.43)	13.8 (.36)	0.84	1.65	—
GK. H3366 (E)	49.5	16.5 (.33)	19.0 (.38)	14.5 (.29)	0.76	1.36	0.45
GK. H5664 (LS+200°)	62.2	19.8 (.32)	26.8 (.43)	19.8 (.32)	0.74	1.60	0.50
TTC. 510530 (LS+180°)	88.6	30.0 (.34)	34.2 (.39)	26.0 (.29)	0.76	1.40	0.41
GK. H8128A (LS+180°)	130.5	46.0 (.35)	51.7 (.40)	31.3 (.24)	0.61	1.58	—
M. aff. *intermedia* for comparison							
YCM.712 (E)	77.4	26.0 (.34)	29.5 (.38)	20.7 (.27)	0.70	1.37	0.47

Observations:—GK. H3362, from Urakawa (Coll. T. M.) is secondarily crushed but preserves the phragmocone and body-chamber up to the peristome. It is illustrated (Fig. 31A—B; Fig. 32A). It is about 115 mm in diameter. It represents evidently a macroconch.

The lectotype (Yokoyama, 1890, pl. 19, figs. 5a, b) from Urakawa, and another fine specimen from South Sakhalin (Matsumoto, 1954b, pl. 23, figs. 1a—c), which I presented to BMNH (C47735), are not crushed and exhibit well the characters of the phragmocone and body-chamber both. They are interpreted as macroconchs, although they lack the apertural margin and somewhat

smaller than GK. H3362. The three specimens have essentially the same characters.

I have not yet obtained a completely preserved example of microconch, but as Matsumoto and Inoma (*in* Matsumoto *et al.*, 1972) have shown in their description of *N. haboroensis,* a trace of lappeted apertural margin worked at one time in the course of growth often remains at some distance adaptically from the last peristome. Similar examples are found in some small specimens of this species. GK. H3350 (Fig. 31C—F) is one of them. Its phragmocone ends at D=41 mm and about a quarter whorl of the body-chamber is incompletely preserved. About 60° back from the last septum there is a distinct trace of a probable base of a peristome at a younger stage, showing a ventral projection, ventrolateral sinus, lateral projection and shallow ocular sinus. As the ribs are somewhat coarser on the body-chamber than those in the last part of the phragmocone, this specimen certainly represents an adult microconch of this species. Its diameter in a restored outline is roughly estimated at 65 to 70 mm.

GK. H8087 (Fig. 33A—C), a well preserved specimen quite similar to the above, is another example of the microconch.

Comparison and discussion:—The predominance of more or less sinuous ribs on the phragmocone and the development of coarse or strong, long ribs on the body-chamber (especially stronger in macroconchs) are the characters which enable us to distinguish this species from any known species of *Kitchinites.*

Because the lectotype of *N. ishikawai* is a small, probably immature shell, a question may arise as to the distinction between this species and nearly contemporary *N. ishikawai.* In my present knowledge *N. ishikawai* has more numerous, denser and finer ribs than those of *N. japonica* at corresponding growth-stage (See Figures 32, 33). Even in the macroconch body-chamber of *N. ishikawai* the ribs are more numerous and weaker, being not so strong and so thick as those of *N. japonica.* In shell-form the extents of variations in the two species are overlapping (See table of dimensions).

GK. H8087 is an example of *N. japonica* occurring in the Coniacian of the Obira area, for it was found by A. Tomita together with *Gauthiericeras* cf. *margae* (Schlüter) (Fig. 33D—E). In this connexion the phylogenetic origin of *N. japonica* should be considered. Someone may

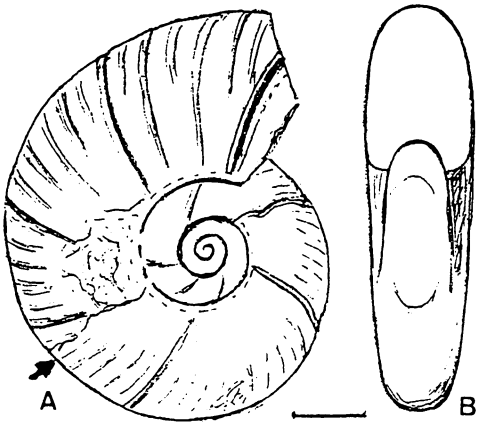


Figure 34. *Kitchinites pondicherryanus* (Kossmat).
A—B: holotype, BMNH. C47548 from the Valudayur Beds. Pondicherry, South India; bar=10 mm. (T. M. *delin.*) See text in p. 13—14.

presume that *N. japonica* may have derived from some species of *Mesopuzosia*. *M. yubarensis* from the Upper Turonian and Coniacian could be a possible candidate of the ancester, but its ribs and constrictions are bent too much strongly forward on the outer whorl and its macroconch is huge and nearly smooth, with only blunt radial undulations on the outer whorl.

YCM. 712 (Fig. 33F—H) of T. Suekane's collection no. A3 from loc. K23 of the Kaneobets, Middle Turonian of the Oyubari area, is interesting in that it has a fairly compressed whorl with flat and subparallel flanks and the periodic constrictions or flares which are somewhat prorsiradiate on the main flank and strongly projected on the venter. It is probably a microconch of *Mesopuzosia* sp. allied to *M. intermedia* (Kossmat, 1898). In this specimen the obliquity of the constrictions to the ribs is not so distinctly shown as in *N. japonica,* but shows a tendency to that character. It resembles to some extent (but not fully) *N. japonica* in shell-form and ribbing. Some of the ribs on its body-chamber are more distinctly sigmoidal than those of *N. japonica.*

Occurrence:—Common in the Santonian and Lower Campanian of Hokkaido and also South Sakhalin. The first appearance is so far in the Upper Coniacian.

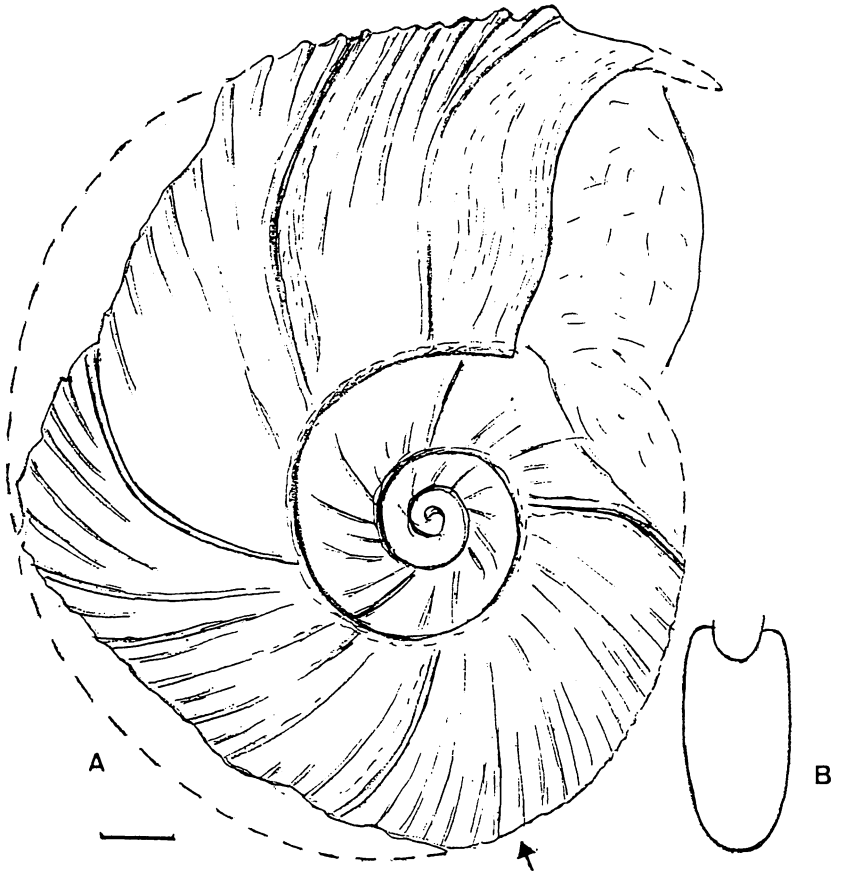


Figure 35. *Kitchinites brevicostatus* (Marshall).
A—B: macroconch, WW. 155 from Whangaroa, New Zealand, showing the apertural margin (A) and whorl-section (B) at about LS; bar = 10 mm. (T. M. *delin.*) See text in p. 14.

Genus *Jimboiceras* Matsumoto, 1954

Jimboiceras planulatiforme (Jimbo)

(By T. Matsumoto, T. Takahashi, Y. Kawashita and T. Shimanuki)

Figures 36—41

1894. *Desmoceras planulatiforme* Jimbo, p. 173 (27); pl. 17 (1), figs. 4, 4a.
1927. *Puzosia planulatiforme* (Jimbo); Yabe. p. 45 (19), pl. 9 (7), figs. 2a, b.
1954. *Jimboiceras planulatiforme* (Jimbo); Matsumoto, 1954b, p. 96, pl. 20, figs. 1, 2, 3a—c (non fig. 4).
1965. *Jimboiceras planulatiforme* (Jimbo); Vereshagin *et al.*, p. 41, pl. 33, figs. 1, 2.

Lectotype:—UMUT. MM 7499 [= I-94], "found near the exposure of Tertiary sandstone on the Obirashibe, about 11 ri (= 44 km) from its mouth" (Jimbo, 1894, pl. 17 (1), figs. 4, 4a) (this paper Fig. 36) (designated by Matsumoto 1959b, p. 21).

Material:—In addition to the lectotype, the representative specimens are as follows: UMUT. MM 6645 (= I-3221) (Fig. 38), from loc. T42, Saku-gakko-no-sawa, Saku Formation (Unit IId)

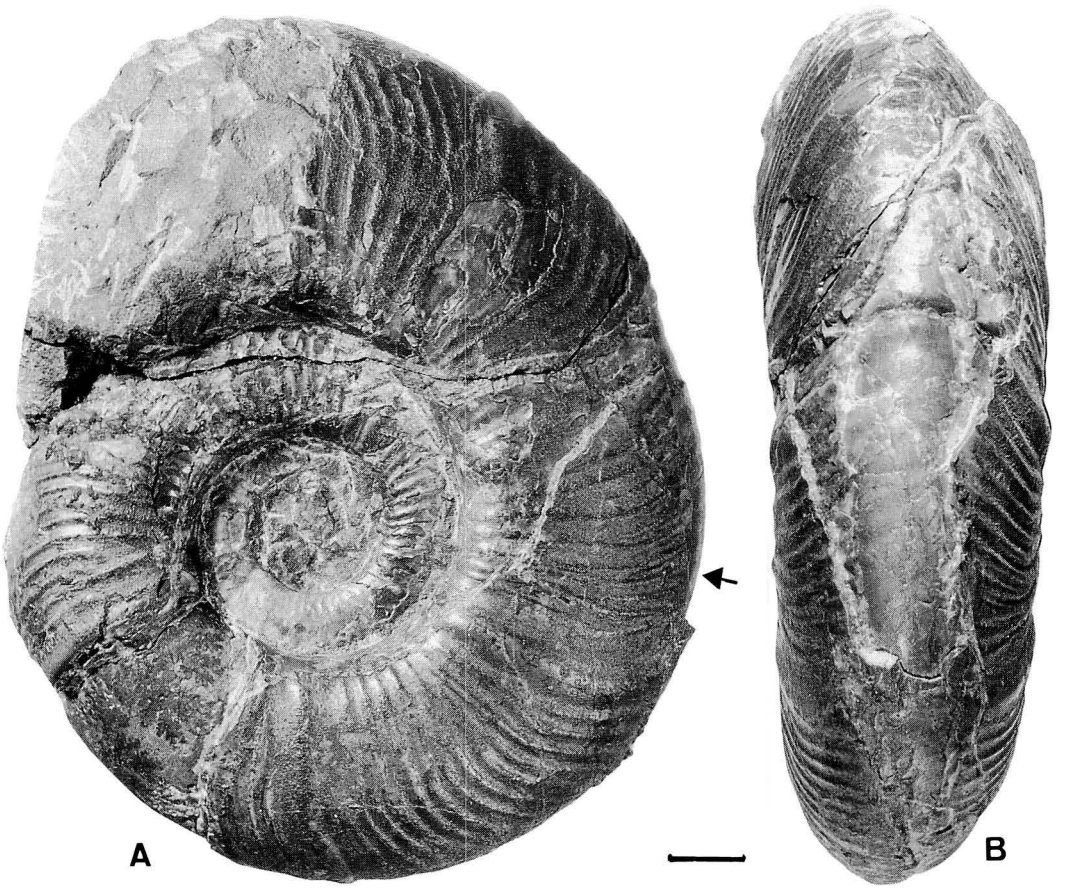


Figure 36. *Jimboiceras planulatiforme* (Jimbo).
A—B: lectotype, UMUT. MM 7499, probably microconch, from the Obirashibe Valley (Coll. K. Jimbo); bar = 10 mm.

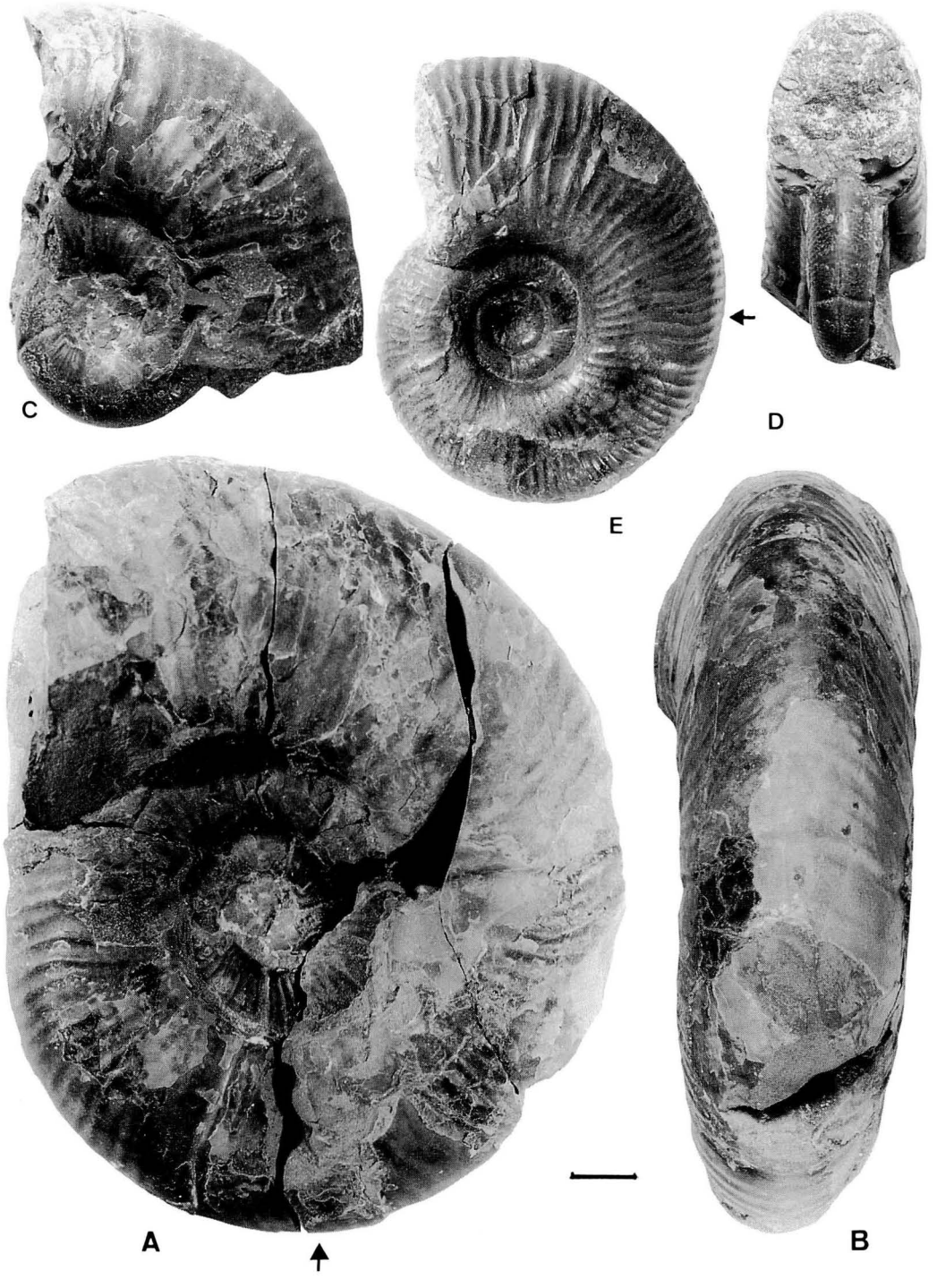


Figure 37. *Jimboiceras planulatiforme* (Jimbo).
A—B: probably microconch, GK. H1259 from loc. Y129 p2, Shiyubari Valley (Coll. T. Matsumoto); C—D: inner whorls of the same specimen; E: immature shell doubtfully referred to *J. planulatiforme* or possibly referable to *Mesopuzosia* aff. *chivensis* (Arkhanguelsky), TTC. 500525 from the Sato-no-sawa, Obira area (Coll. T. Takahashi); bar = 10 mm.

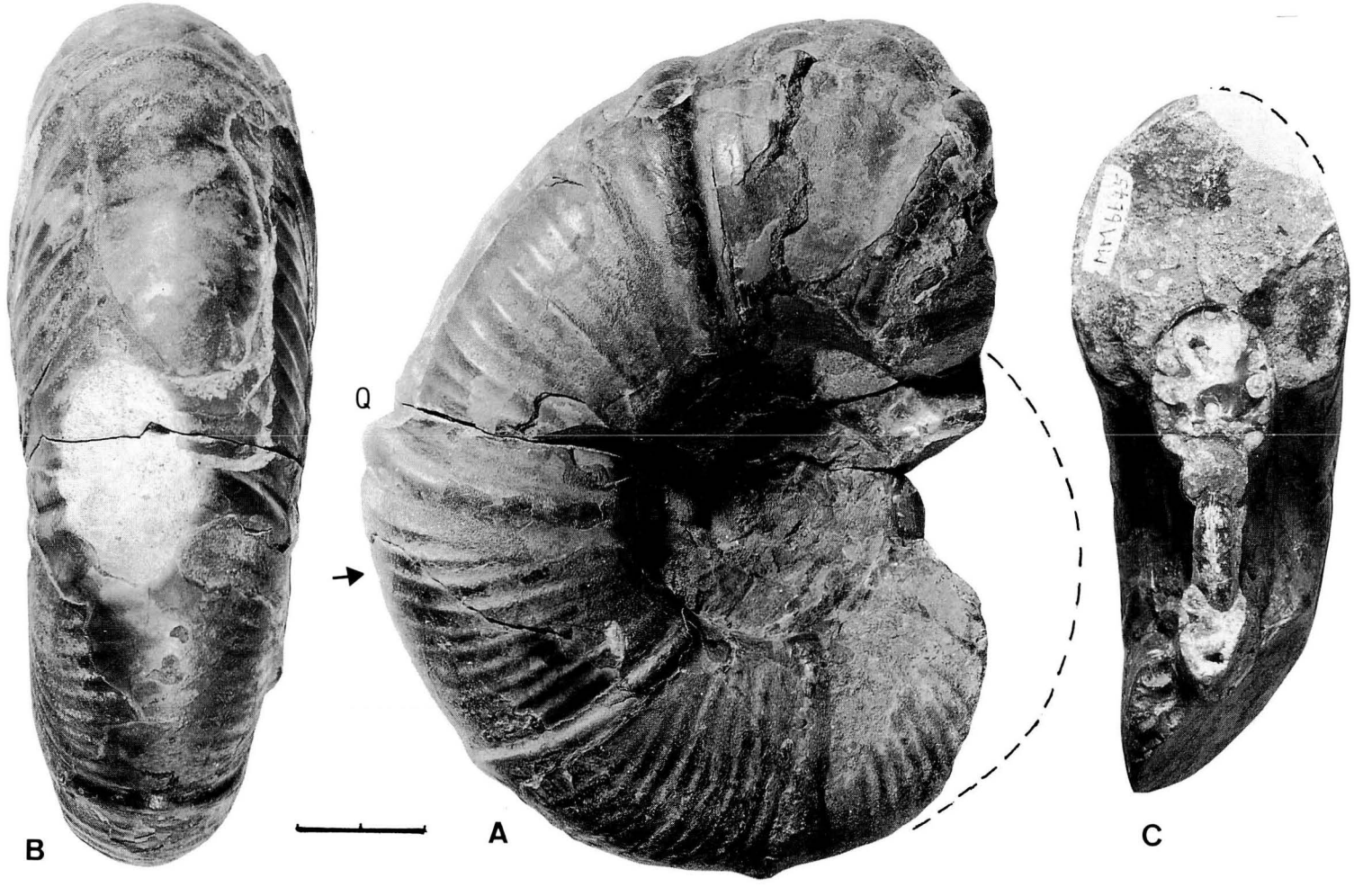


Figure 38. *Jimboiceras planulatiforme* (Jimbo).
A—C: probably microconch, UMUT. MM 6645 from loc. T42, Abeshinai-Saku area (Coll. T. Matsumoto); scale bar = 20 mm.

(T. Matsumoto Coll.); GK. H1259 (Fig. 37A—D) from loc. Y129 p2 of the Shiyubari Valley (Coll. T. Matsumoto); TTC. 480513 and TTC. 560600 (Fig. 41C—E), Sato-no-sawa, Kamikinembets, a tributary to the River Obirashibe (T. Takahashi Coll.); T. Shimanuki's Coll. from the same locality (Fig. 41A—B); TTC. 500525 (Fig. 37E), from Migi-mata, Sato-no-sawa, Obirashibe Valley (T. Takahashi Coll.); TTC. 580912 (Fig. 40), in a floated nodule of the Hakkin-zawa, Oyubari area, T. Takahashi Coll. (well preserved macroconch showing the peristome); YKC. 760905 (Fig. 39A—D) in Y. Kawashita's Coll., from the Ban-no-sawa, a tributary to the Panke-moyuparo River, showing the peristome. Other specimens listed in Matsumoto (1954b, p. 97), excluding GT. I-2651 (misprinted as 2951 in the explanation of pl. 20) [=UMUT. MM 6646], are also examples of this species.

Diagnosis:—Microconch medium-sized, with ventral rostrum and lateral lappets on the apertural margin; macroconch fairly large, with ventral rostrum and no lateral lappet on the apertural margin.

Thickly discoidal shell, with moderate rate of whorl expansion and umbilicus of moderate

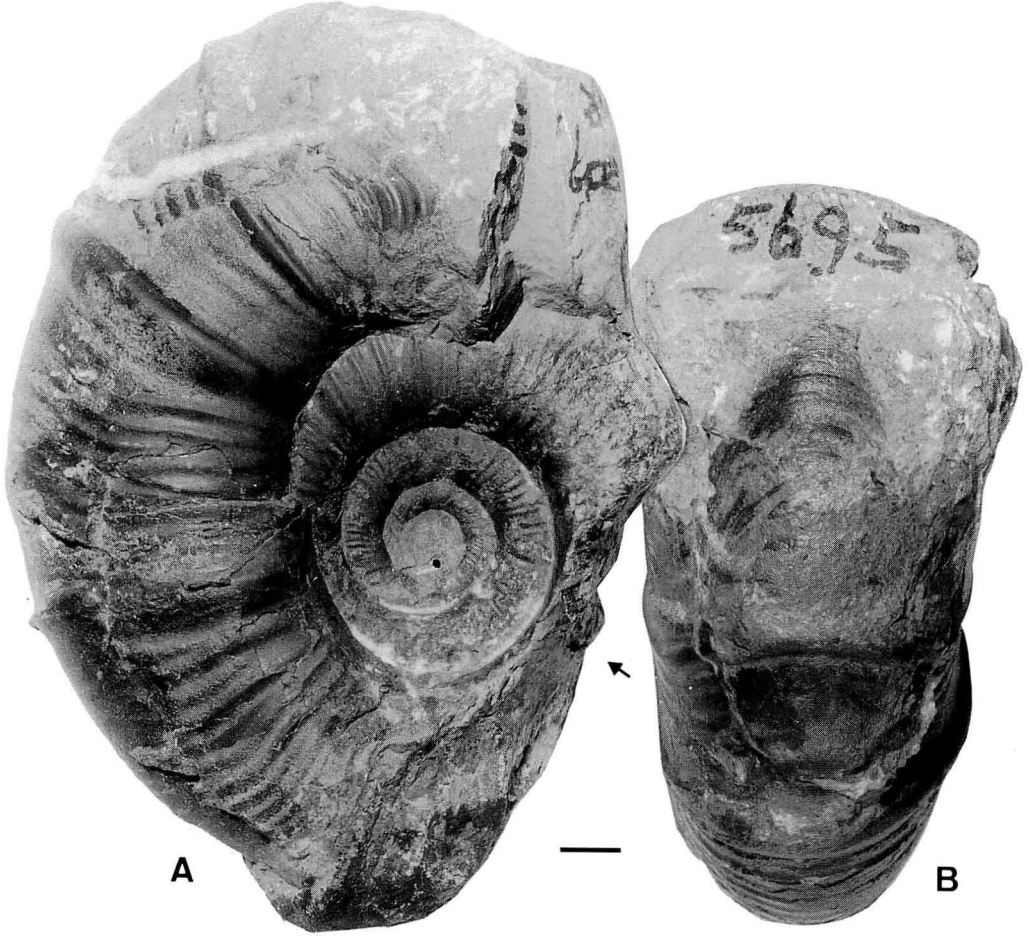
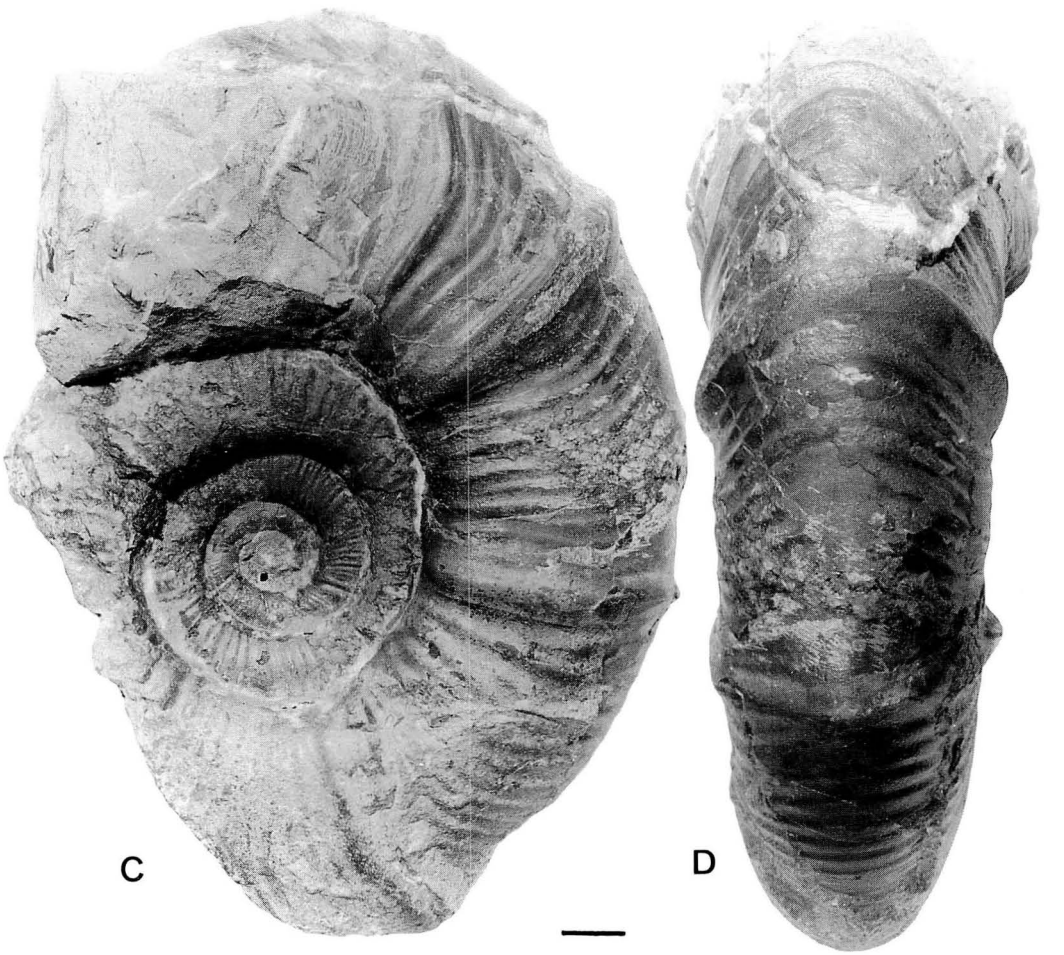


Figure 39. *Jimboiceras planulatiforme* (Jimbo).
A—D: microconch showing the peristome, YKC. 960905 from the Ban-no-sawa, tributary to

width on the average. Whorl subrounded to subtrigonal in cross-section, with convex flanks and rounded to subrounded umbilical shoulder and broadest at a point between the mid-flank and umbilical shoulder, showing 0.86 to 0.96 in B/H.

Ribs well develop from fine subcostae in fairly early immature shell to distinct and moderately coarse ones in the adult, more or less flexuous on the flank, some being subradial on inner flank and others somewhat sigmoidal; also some branching (bifurcating) outward at about the mid-flank and some others intercalating shorter ones on the outer flank; all the ribs moderately projected on the outer part of the whorl (i.e. on the outer flank and venter). Constrictions well marked, fairly frequent (5 to 7 per whorl), gently sigmoidal or rather simply arcuate (i.e. concave forward) on the flank and moderately projected on the outer part.

The ribs gradually coarsen and the flares thicken and strengthen on the adult body-chamber, where the flares number at least five, of which the last two may be approximated. The macro- and microconchs not much different in ornamentation, but the ribs and flares are generally coarser and stronger in the late growth-stage of the macroconch. The ventral rostrum provided with several



the Panke-moyuparo River, south of Oyubari area (Coll. Y. Kawashita); bar = 10 mm.

riblets on its basal part and dense lirae on its apical portion.

Suture of the same pattern as that of *Puzosia* and *Mesopuzosia*.

Dimensions:—

Specimen	D	U	H	B	B/H	H/h
Lectotype* (E)	113.5	43.5 (.38)	40.5 (.36)	37.8 (.33)	0.93	1.38
Lectotype (E–90°)	93.0	38.5 (.36)	34.8 (.37)	33.5 (.36)	0.96	—
TTC. 480513** (E)	117.0	44.4 (.38)	43.0 (.36)	37.3 (.32)	0.87	1.34
TTC. 480513 (E–135°)	86.0	31.8 (.37)	32.4 (.38)	30.1 (.35)	0.93	—
TTC. 500525	69.0	21.0 (.30)	29.2 (.42)	27.0 (.39)	0.92	1.53
TTC. 560600	60.0	19.8 (.33)	22.0 (.37)	22.0 (.37)	1.0	1.21
TTC. 601124	*c.* 146.0	54.0 (.37)	—	—	—	—
TTC. 601124***	119.0	45.0 (.38)	44.6 (.37)	39.0 (.33)	0.87	1.49
UMUT. MM 6645	120.0	40.0 (.33)	47.0 (.39)	45.4 (.38)	0.96	1.34
GK. H1259* (E)	116.6	44.6 (.38)	42.5 (.36)	40.4 (.35)	0.95	1.44
GK. H1259 (E–240°)	72.0	27.4 (.38)	28.6 (.39)	26.2 (.36)	0.92	—
TTC. 580912	182.0	68.0 (.37)	64.2 (.36)	56.0 (.31)	0.87	1.41

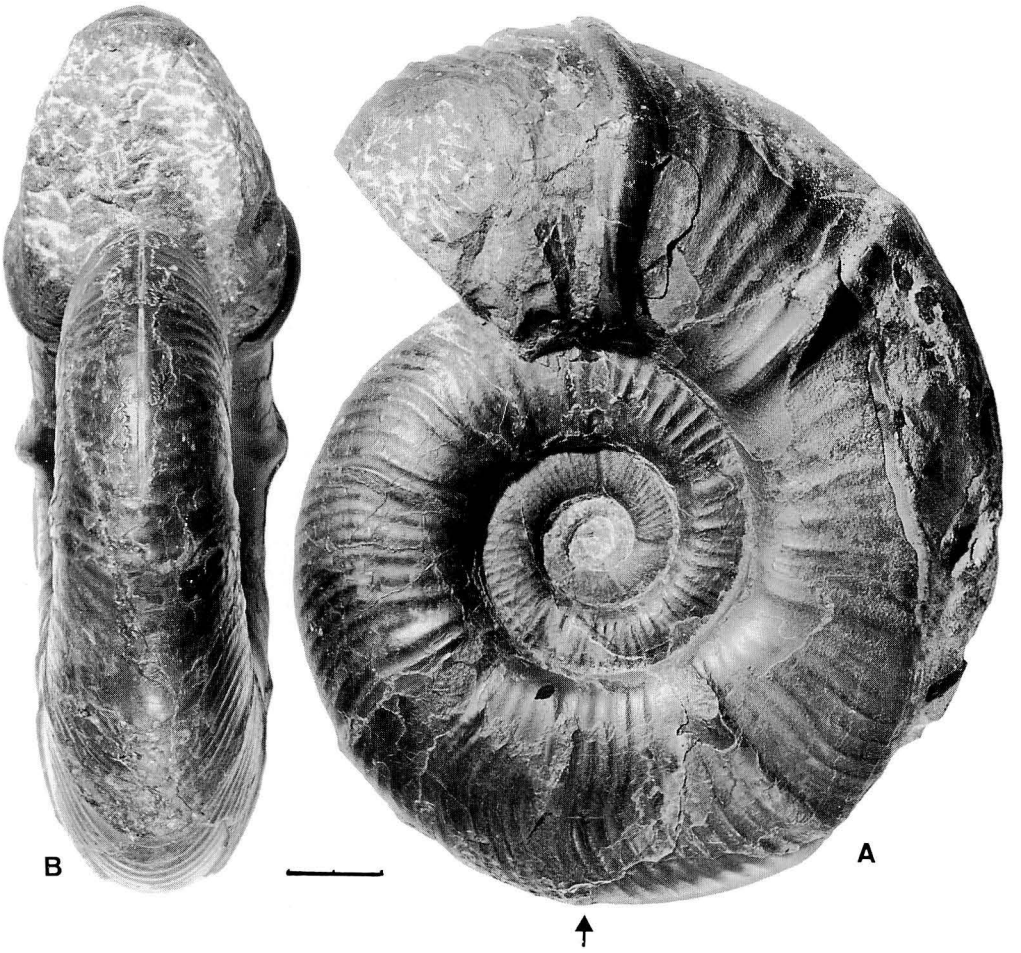
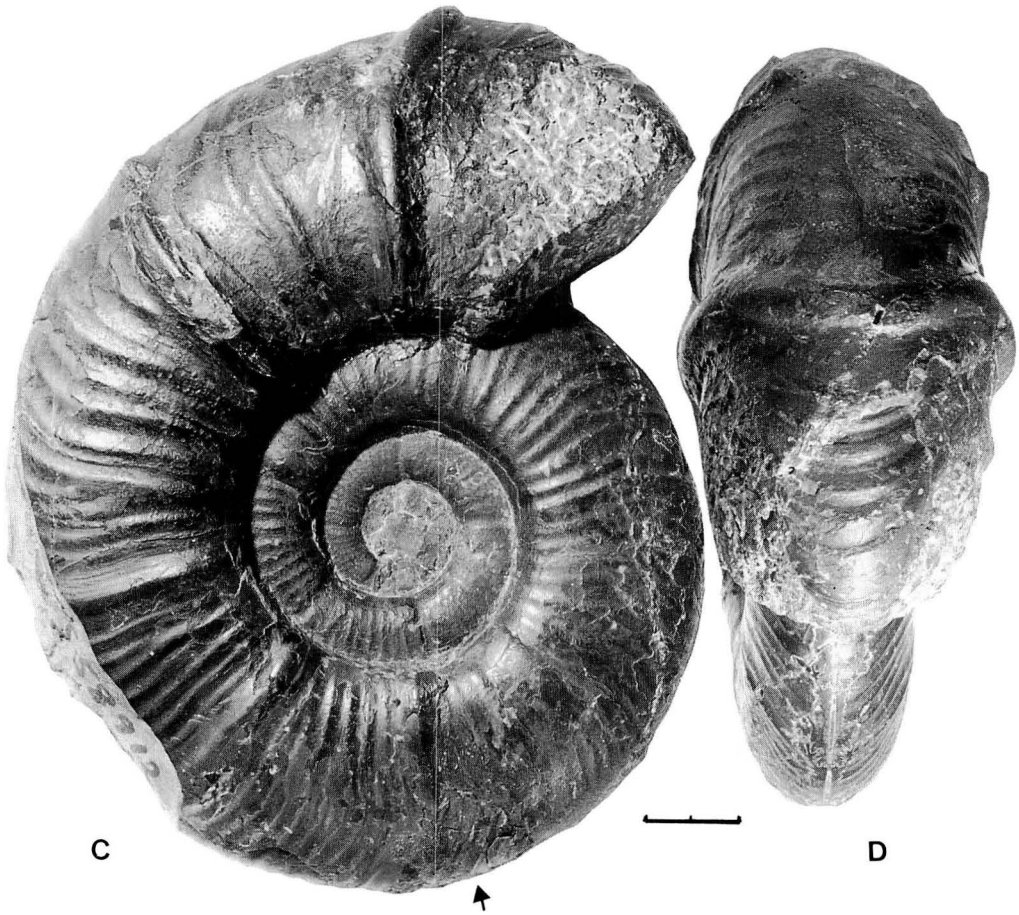


Figure 40. *Jimboiceras planulatiforme* (Jimbo).
A—D: macroconch, TTC. 580912 from the Hakkin-zawa, Oyubari area (T. Takahashi Coll.), showing

TTC. 580912 (last flare)	—	—	67.5	64.7	0.96	—
TTC. 580912 (−150°)	136.0	50.0 (.37)	50.2 (.37)	44.0 (.32)	0.88	1.37
Shimanuki's	125.5	43.8 (.35)	49.0 (.39)	47.0 (.37)	0.96	1.38
Kawashita's	*c.* 145.0	*c.* 53.5 (.37)	52.0 (.36)	44.5 (.31)	0.86	1.33

*at the preserved end, about 90° adorally from the last septum; **at the preserved end, about the middle of the body-chamber; ***at the measurable last point = 100° adorally from the last septum; D = 146.0 in TTC. 601124 restored from the measured width of umbilicus on the assumption that U/D = 0.37; Shimanuki's specimen: at the end of the phragmocone; Kawashita's specimen: restored diameter at the point immediately behind the last flare.

Observations:—The examined specimens are grouped into two forms which differ clearly in size. The larger form is represented by TTC. 580912 (Fig. 40), whose diameter is nearly 185 mm at the full-grown stage and about 125 mm at the last septum. This specimen preserves the peristome where there is a ventral rostum but no lateral lappets. Shimanuki's specimen (Fig. 41A—B) is also another example, because the last septum is at diameter of 125.5 mm. Although the main part of its body-chamber is not preserved, its umbilical seam is traced for about 250°. Therefore, its entire shell diameter must have been at least 190 mm.



the apertural margin; the rostrum and the last flare in ventral view are particularly shown in D. Scale bar = 20 mm.

The lectotype has the last suture at about 95 mm in diameter and its body-chamber is incompletely preserved. Kawashita's specimen is deficient in lacking considerably the outer part at and near the last septum and somewhat distorted secondarily, but it preserves the apertural margin where ventral rostrum and lateral lappets are shown. Its diameter is about 145 mm at the mid-point between the approximated last flares and about 95 mm at the last septum in the restored outline. Several others, such as UMUT. MM 6645, GK. H1259, TTC. 480513, TTC. 601124, have the last septum at diameter of 95 mm or so, although their body-chamber is more or less incomplete. All of these specimens certainly represent the adult microconchs.

While the above observations are warranted, the sentences in three lines in the lower part of p. 97 in Matsumoto (1954b) are incorrect. To quote from the original: "In the fairly large adult shell the ornament consists of strong and broadly rounded ribs separated by flat interspaces as wide as or somewhat wider than the ribs. The ribs cross the venter without or with a slight ventral bend." The error came from the misunderstanding that a fragmentary piece of outer whorl (GT. I-2651A; Matsumoto, 1954b, pl. 20, fig. 4) was regarded as a portion of an adult shell of this species and that the phragmocone (unillustrated in 1954) in the same nodule was thought as that of this species. In this paper the latter (GT. I-2651B, this paper Fig. 18) is regarded as an example of *Mesopuzosia takahashii* and the former is unrelated with that species, being possibly a piece of outer whorl of some species of *Pachydesmoceras*.

The immature shell is observable in many cases as the inner whorls of the adult shell, from which it can be separated from a favourably broken specimen. GK. H1259 (Fig. 37A—D) is such an example, whereas TTC. 500525 (Fig. 37E) may be an isolated immature shell which preserves incompletely the body-chamber for about 90°. As the outward projection of its ribs is less pronounced, it could be a young shell of *Mesopuzosia* aff. *chivensis*.

The diagnostic features of this species begin to appear in the middle-aged shell at about 50 to 60 mm in diameter. At still younger stages the distinction of this species from certain others may be difficult, unless a shell of later stages is associated.

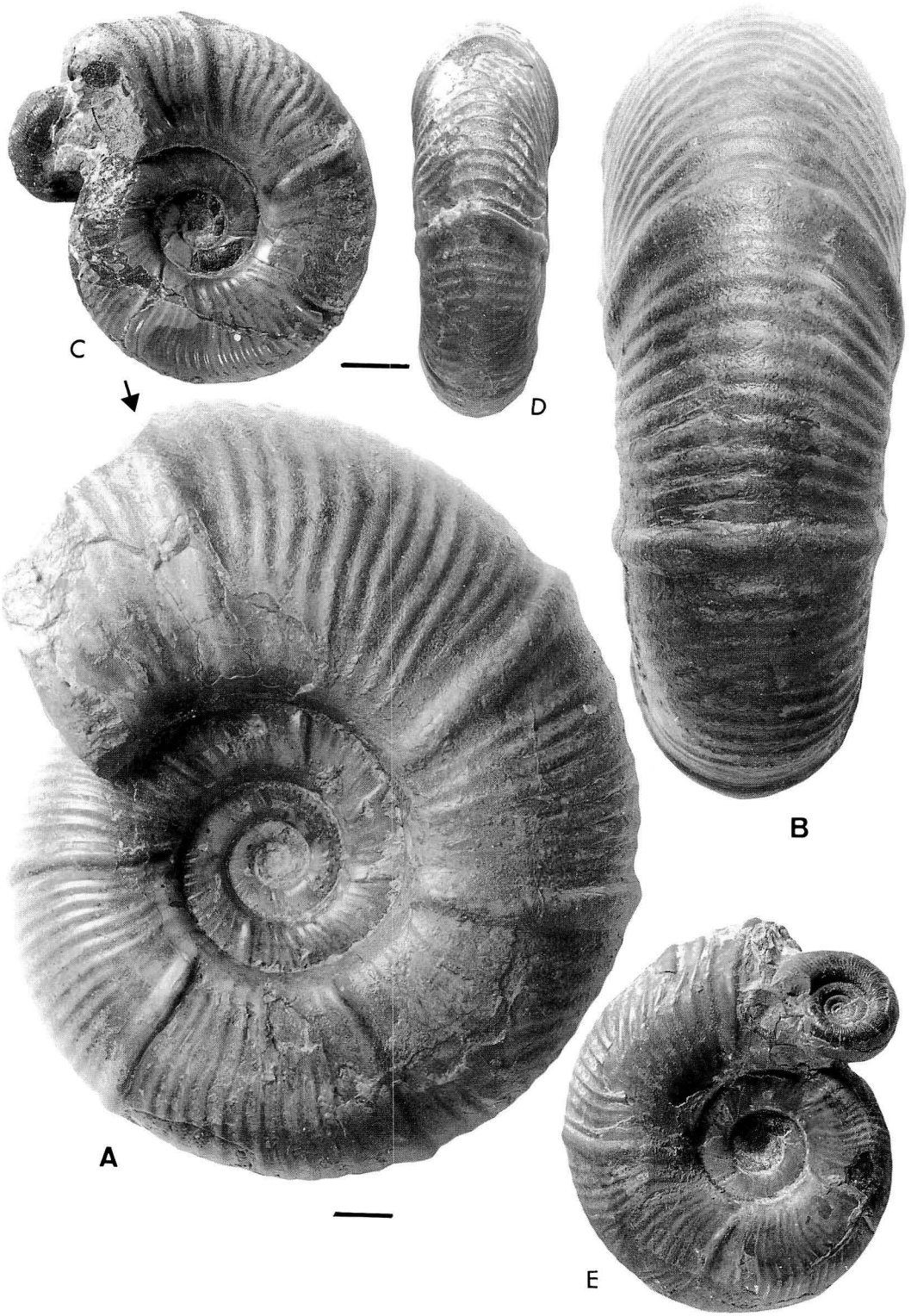
Incidentally, TTC. 560600 (Fig. 41C—E), another isolated immature shell from a locality close to that of TTC. 500525, has on its left side a spiral trace of injury by which the ribs are modified to take a peculiar or irregular course, but its right side is normal.

Apart from this special case, the ribs show some variation in the degree of flexuosity and mode of bifurcation. Normally the bifurcation or intercalation occurs at about the mid-flank or well below (or inward) on the inner flank at the point not far from the umbilical margin. This is in contrast to the ribbing on the phragmocone of *Anapuzosia* spp. (see Renz, 1972) in which the ribs are bifurcated more frequently on the outer flank. This can be reckoned as one of distinctions between *Anapuzosia* and *Jimboiceras*. In the latter the bifurcation is infrequent and that on the outer flank is very rare.

Occurrence:—This species occurs fairly commonly in the middle part of the Turonian in Hokkaido, i.e. in the Zone of *Inoceramus hobetsensis* and the part immediately below that zone. As several well preserved specimens were obtained in fallen or floated nodules, the true stratigraphical range of this species has yet to be worked out.

Examples are also reported from the Turonian of the Pacific province of the USSR

Figure 41. *Jimboiceras planulatiforme* (Jimbo). →
A—B: macroconch, mainly phragmocone, T. Shimanuki Coll. from the Sato-no-sawa, Obira area; bar = 10 mm. C—E: young shell with injury on the left side (E), TTC. 560600 from the Sato-no-sawa, Obira area (Coll. T. Takahashi); bar = 10 mm.


C
D
B
A
E

(Verechagin *et al.*, 1965) and comparable or allied forms from the Turonian of California (Matsumoto, 1959b, p. 21) and Madagascar (Collignon, 1961; 1965).

Genus *Austiniceras* Spath, 1922

Austiniceras austeni (Sharpe)

(By T. Matsumoto, K. Muramoto and Y. Kawashita)

Figures 42—44

1855. *Ammonites Austeni* Sharpe, p. 28, pl. 12, fig. 1.
1954b. *Puzosia* (?) *ambigua* Matsumoto, p. 78, pl. 10, figs. 2, 3.
1971. *Austiniceras austeni* (Sharpe); Kennedy, p. 38, pl. 11, fig. 1; pl. 12, fig. 1.
1984. *Parapuzosia* (*Austiniceras*) *austeni* (Sharpe); Wright & Kennedy, p. 60 (with synonymy list), pl. 5, figs. 3, 6; text-fig. 5.

Lectotype:—BMNH. C3382 (Sharpe, 1855, pl. 12, figs. 1a, b; Kennedy, 1971, pl. 11, fig. 1: pl. 12, fig. 1), from the Lower Chalk of Guildford, England, designated by Spath (1922, p. 127).

Material:—Koji Hasegawa's Collection 530310 from the bed with *Calycoceras* (*Newboldiceras*) *asiaticum* of the Mikasa Sandstone at Shimo-katsura-zawa, Ikushumbets Valley, which is now on display at MCM. (Fig. 42); three specimens in the Muramotos' Collection, from loc. Ik 1045 of the Suido-no-sawa (a right tributary), loc. Ik 1039 and loc. Ik 1040 on the left and right banks of the River Ikushumbets; another specimen from loc. Ik 1044 (close to Ik 1045) in the Collection of Mikasa High School. GK. H8130 (Fig. 43) from a boulder of the terrace gravel on Yu-no-sawa tunnel probably derived from the Mikasa Sandstone (Coll. Mikasa High School transferred to GK.); YKC. 550621 (Fig. 44) from the upper reaches of the Obirashibe (Coll. Y. Kawashita). UMUT. MM 6612—6613, the holotype of *Puzosia* (?) *ambigua* Matsumoto (1954b, pl. 10, fig. 3), from loc. N306d, Zone Mho in the Naibuchi area, S. Sakhalin, and other specimens under the same specific name from the same area and the Saku area of Hokkaido.

Diagnosis:—See Wright and Kennedy (1984, p. 60).

Dimensions:—

Specimen	D	U	H	B	B/H	H/h
(1)	352	86 (.24)	162 (.46)	*c.* 88 (.25)	0.54	1.56
(2)	328	85 (.26)	145 (.45)	secondary compressed		1.50
(3)	427	122 (.29)	181 (.42)	117 (.28)	0.65	1.45
(4)	384	99 (.26)	168 (.44)	105 (.27)	0.62	1.44
(5)	403	116 (.29)	167 (.41)	*c.* 105 (.26)	0.62	1.39

(1) KHC. 530310, (2) MC. from Ik 1045, (3) MC. from Ik 1089, (4) Mikasa High School Coll., (5) lectotype, T.M.'s measurements, which differ from Kennedy's (1971, p. 39) in whorl-breadth.

Observations:—KHC. 530310 is well preserved on both sides and almost undeformed, with shell layer partly preserved. The head of the last suture is at diameter of 340 mm, with only a fraction of the body-chamber in front of it. There is still a trace of at least half whorl, which was overlapped by the main part of the body-chamber. Therefore, the entire shell diameter must have been at least 520 mm. Other three measured specimens are all septate.

Although there is some variation in the measured ratio of H/h or B/H, the five specimens

from the Mikasa [Ikushumbets] area have commonly a narrow, subtrigonal cross-section of the outer whorl, with a narrowly arched venter, convergent flanks which are flattened on the main part, the maximum breadth in the dorsal part slightly above the subangular umbilical shoulder and low but vertical umbilical wall. This shell-form is quite similar to that of the specimens of *A. austeni* from England. The difference in the ratio of B/H may be due partly to variation with growth-stage and presumably between micro- and macroconchs, as well as among individuals, and partly to some effect of secondary deformation. GK. H8130 is much distorted.

The umbilical ratio (U/D) of the measured specimens of Mikasa is somewhat variable and not much different from that of the lectotype. There is no significant difference in the degree of involution. The rate of increase in whorl-height is somewhat larger in some of our specimens than in the lectotype, but the difference can be regarded as a variation.

Visible inner part of the flank is nearly smooth and constricted in the inner whorl as in that of the British specimens. The mode of ribbing on the preserved outer whorl of the Mikasa specimens is quite similar to that of the lectotype and other British examples of *A. austeni.* The major ribs starting at the umbilical shoulder are at first periodic flares along narrow and indistinct constrictions and then become more frequent and more elevated without constrictions. They show

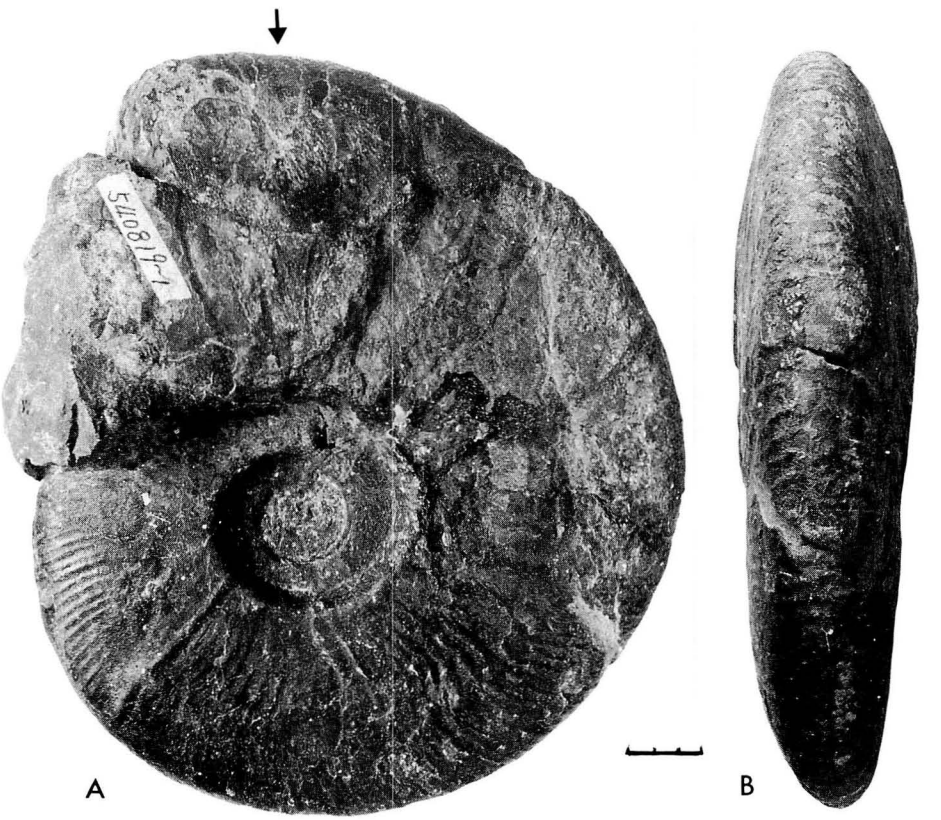


Figure 42. *Austiniceras austeni* (Sharpe).
A—B: a very large example, mainly phragmocone, from the bed with *Calycoceras (Newboldiceras) asiaticum* (Jimbo) of the Mikasa Sandstone Formation at Shimo-katsura-zawa, Ikushumbets Valley (Coll. K. Hasegawa 530310, now on display at MCM); scale bar = 30 mm.

a very gentle flexuosity on the main part of the flank and then a forward concave curve on the outer lateral part, crossing the venter with projection. Minor ribs are numerous, although of various number on the interspaces of the major ones according to the frequency of the latter. They are narrower, weaker and shorter than the major ribs, being more distinct on the outer lateral and ventral parts and projected like the major ones.

If we look at carefully the well preserved specimens, we notice that the minor ribs are of unequal length on the outer whorl; some of them are extended to the inner part of the flank, although much weakened. This character is also shown by the lectotype and also another illustrated specimen (Wright & Kennedy, 1984, pl. 5, fig. 6b) from England. Shorter

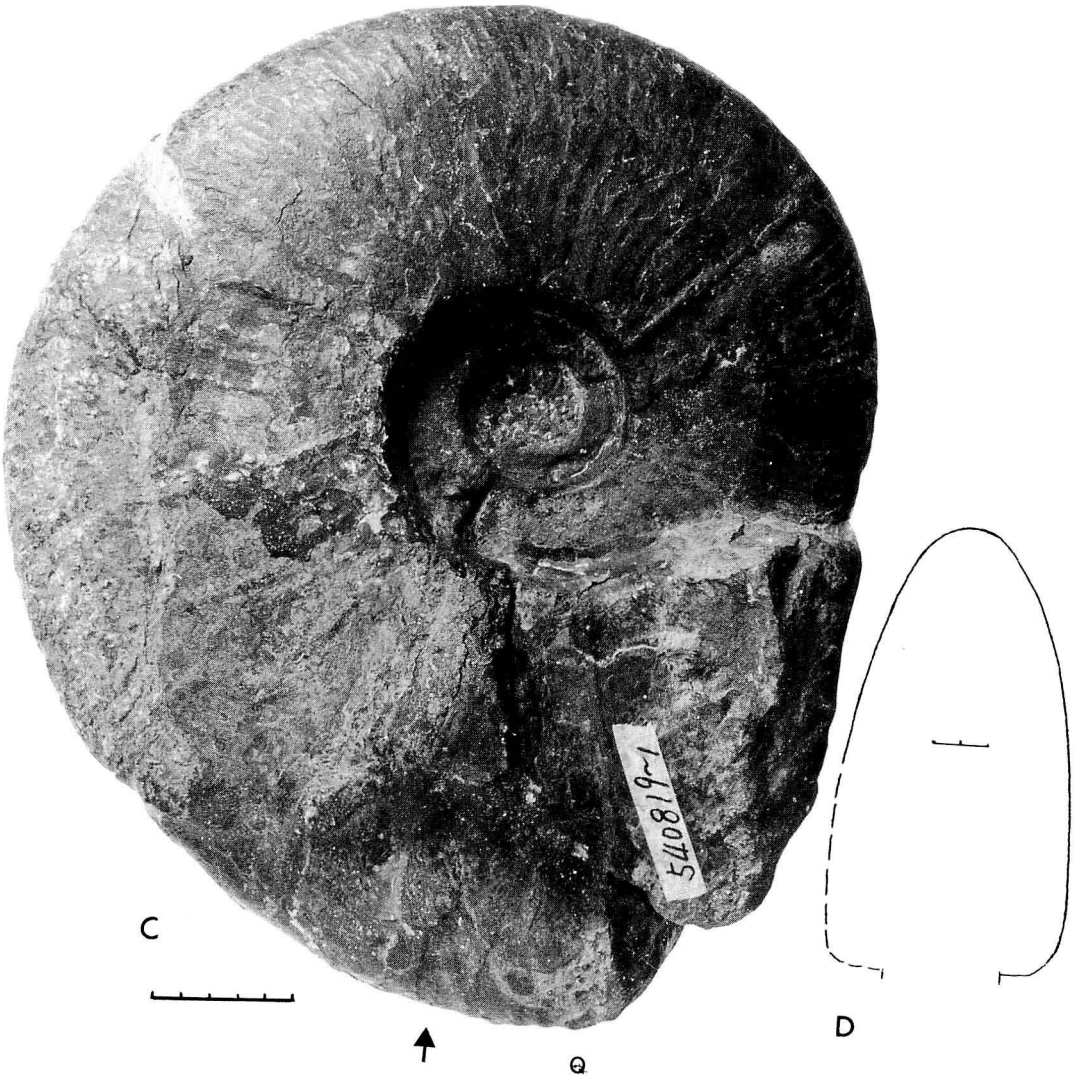


Figure 42. *Austiniceras austeni* (Sharpe).
C—D: the same specimen as Fig. 42A—B, in the light of different orientation (C) and a diagrammatic whorl-section (D) at Q. Scale bar = 50 mm in C and 20 mm in D.

outer ribs may be branched from this weak longer minor ribs or intercalated between the latter. Similarly the major ribs may be branched into two or three minor ribs, or weakened singly to minor ones, or extended to the venter singly without noticeable weakening. These aspects of variance are observable also on the lectotype and other examples of *A. austeni* from England.

In the late stage of the first two specimens, i.e. (1) and (2) in the table of measurements, the major ribs become frequent and elevated but rather narrow and the minor ribs are fine and numerous. This feature is quite similar to that of the lectotype. On the preserved outer whorl of the third and fourth specimens from Mikasa, the major ribs become frequent but rather blunt and thick and the minor ribs are not so fine and so numerous as those of the first two specimens. The last portion of the phragmocone in the third specimen is nearly smooth, suggesting a faintly ribbed or nearly smooth body-chamber, whereas the major and minor ribs tend to persist on

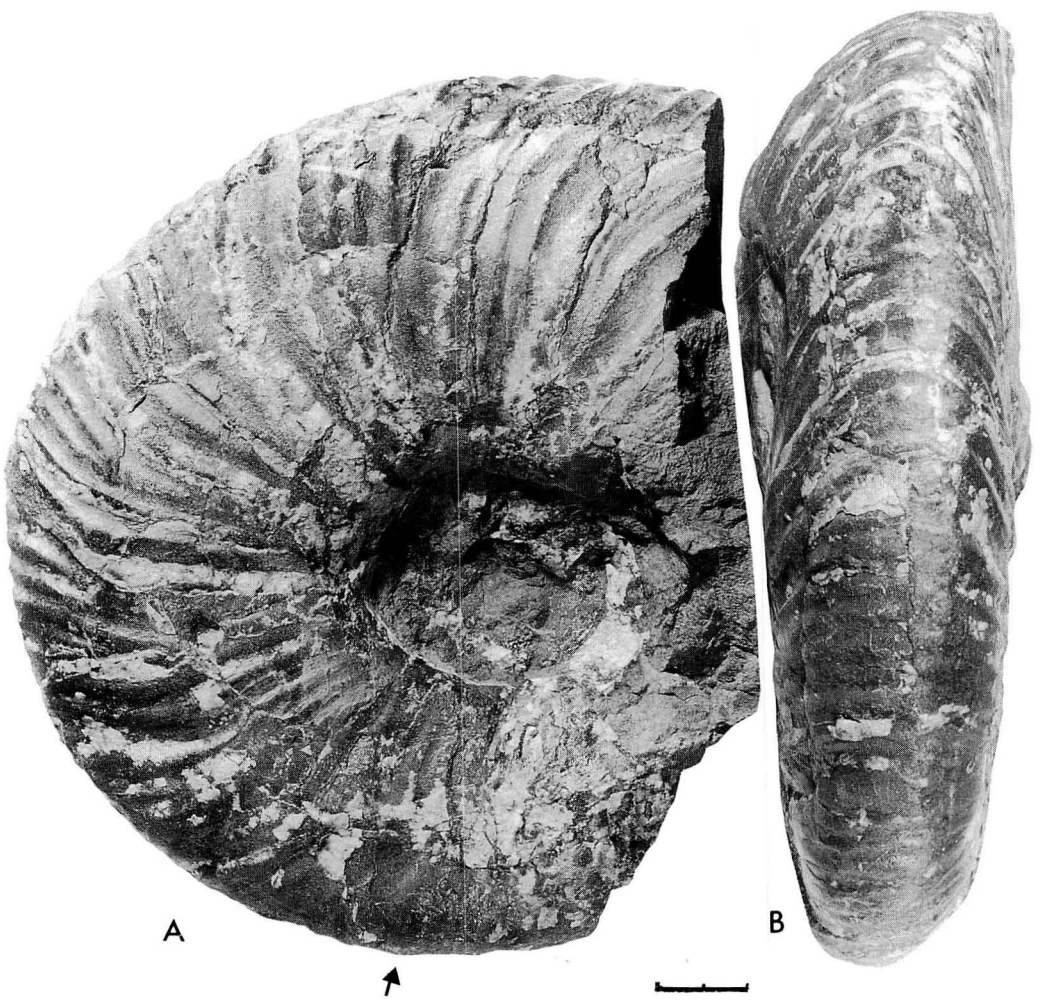


Figure 43. *Austiniceras austeni* (Sharpe).
A—B: probably microconch, distorted secondarily, GK. H8130 (Mikasa High School No. 15) from a boulder of terrace gravel on the Yuno-sawa tunnel, derived from the Mikasa Sandstone; scale bar = 20 mm.

the body-chamber of the first specimen. On the body-chamber of the specimen from Ik 1040 the ribs become blunt and thick. Although the body-chamber is always incomplete, I presume that the first two may represent microconchs and the last three macroconchs. Similarly the lectotype, which has frequent and distinct major ribs on the body-chamber, may represent an adult microconch. It is fairly large, but much larger specimens, which might be macroconchs, occur in England.

GK. H8130, though much deformed, shows the last suture at D = 120 mm and the succeeding

Figure 44. *Austiniceras austeni* (Sharpe).
Another large example (macroconch ?), with left side embedded and dissolved in rock matrix, YKC. 550621 from the upper reaches of the Obirashibe River (Coll. Y. Kawashita); scale bar = 30 mm.

body-chamber has comparatively coarser ribs in spite of the smaller size of the shell. This may be a microconch but is not complete.

On examining the holotype, UMUT. MM 6612—6613 (= GT. I-2639), and other specimens (GT. I-2640, I-3189, I-3190 and I-3197) of *Puzosia* (?) *ambigua* Matsumoto (1954b, p. 78, pl. 10, figs. 2, 3), we have noticed that they are closely similar in the shell-form and ribbing to certain parts of *A. austeni.* Therefore, *P.* (?) *ambigua* most probably falls in a synonym of *A. austeni.* As the original specimens are incompletely preserved, a definite conclusion should be given on a study of better preserved specimens from the same zone, that is Zone Mho of the Naibuchi area and Unit IIb of the Saku area.

Occurrence:—The described six specimens were obtained from the Mikasa Formation of the Ikushumbets (Mikasa) area, central Hokkaido. The known range is from the Zone of *Calycoceras* (*Newboldiceras*) *asiaticum*, Lower Sandstone (IIb) of the formation, to the bed with *Eucalycoceras pentagonum* (Jukes-Browne) (loc. Ik. 1039) in the Middle Siltstone (IIc) of the same formation, that is from the Middle to lower Upper Cenomanian (see Matsumoto, 1975, p. 157—158).

The specimens described under *Puzosia* (?) *ambigua,* a probable synonym of *A. austeni,* were from Zone Mho of the Naibuchi area, South Sakhalin and also Unit IIb of the Saku area, northwestern Hokkaido. These units are probably referred to the Middle to Upper Cenomanian.

A. austeni is recorded in England to range from the Zone of *Mantelliceras mantelli* to the Zone of *Collignoniceras woollgari,* that is from the Lower Cenomanian to the Middle Turonian, and also in other areas of Europe and perhaps South Africa (Wright & Kennedy, 1984, p. 61).

Austiniceras nipponicum (Matsumoto)

(By T. Matsumoto and Y. Kera)

Figures 45—46

1954. *Puzosia nipponica* Matsumoto, 1954b, p. 77, pl. 10, fig. 1; pl. 11, figs. 1a—c.

Holotype:—UMUT. MM 6600 [= GT. I-3191] (Matsumoto, 1954b, pl. 10, fig. 1), from loc. T547p, bed IIb of the Middle Yezo Group in the Abeshinai-Saku area, Teshio Mountains (Coll. T. M.).

Paratypes:—The specimens listed in p. 77 of Matsumoto (1954b) are mostly kept in UMUT., receiving new numbers (see the Catalogue by Ichikawa and Hayami, 1978, p. 214), except for the one, GK. H1221 (Matsumoto, 1954b, pl. 14, figs. 1a—c; this paper Fig. 45) from loc. Y-141, Member IIk of the Middle Yezo Group, the Hikage-zawa, Oyubari area (Coll. T. M.) (see Matsumoto, 1942 for the locations and stratigraphy).

Material in the subsequent collection:—Y. Kera's no. 401 (Fig. 46), a boulder from the pebble bearing calcareous sandstone in the upper reaches of the Ohmaki-zawa, 500 m downstream from a branching point, Oyubari area.

Diagnosis:—Shell large and discoidal; umbilicus of moderate width, surrounded by low but vertical wall and subangular to abruptly subrounded shoulder. Whorls moderately involute, about a half of the inner one being overlapped by the outer, much higher than broad, with moderate to slightly high rate of expansion in whorl-height; venter moderately to rather narrowly arched from early to late growth-stage; flanks slightly convex or rather flat and very gently convergent toward the venter.

Constrictions of moderate frequency on the phragmocone, well marked on the inner whorls, becoming shallower and indistinct on the outer whorl, where they are replaced by flares or major ribs which become more frequent on the late part. Constrictions and flares more or less sigmoidal on the flank and moderately projected on the outer part of the whorls.

Unequally long ribs, distinct on the outer part and faint but discernible on the inner flank in the young to middle-aged shell with diameters over 50 mm or so; more regular and finer,

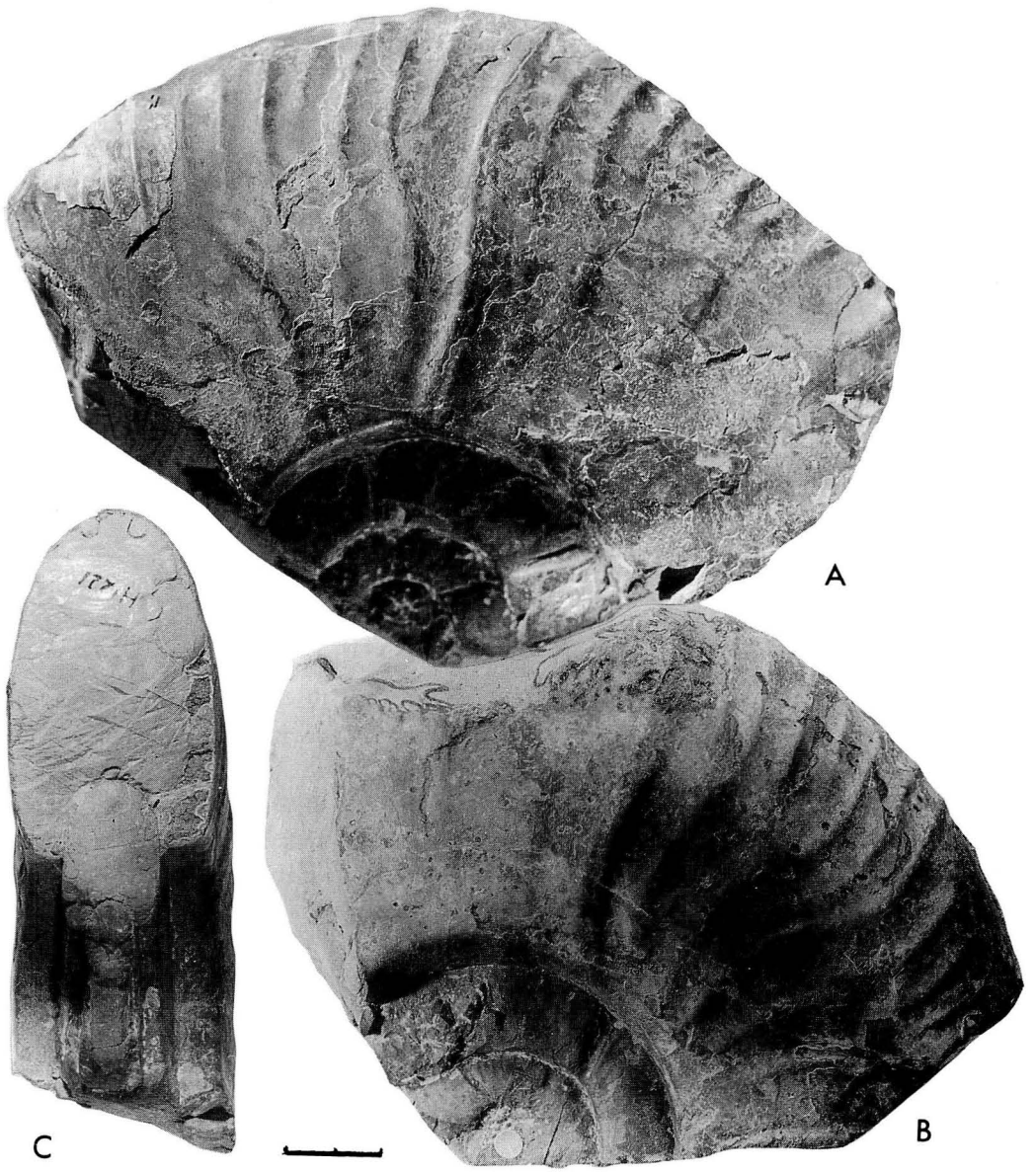


Figure 45. *Austiniceras nipponicum* (Matsumoto).
A—C: paratype, GK. H1221 from loc. Y141, Hikage-zawa, Member IIk of the Middle Yezo Group, Shiyubari-Oyubari area (T. Matsumoto Coll.); scale bar = 20 mm.

numerous subcostae or minor ribs on the outer part (i.e. outer flank and venter) in the same stages, showing moderate projection.

In the late growth-stages, ribs gradually coarsen, becoming fairly distinct, and flares or major ribs frequent; several ribs of unequal length on each interspace of flares or major ribs, some reaching near the umbilical margin and more or less sigmoidal, some others unequally shorter and inserted between the longer ones or disposed as if branched from but slightly separated from the sigmoidal longer ones; on the outer part all the ribs of moderate intensity and regularly disposed, showing moderate projection.

Body-chamber nearly smooth at least partly.

Suture similar to that of *Puzosia*.

Dimensions:—

Specimen	D	U	H	B	B/H	H/h	Inv
Holotype	243.0	75.0 (.31)	100.0 (.41)	63 (?) (.26)	0.63	1.41	—
GK. H1221 (E-65°)	—	—	90.0	54.0	0.60	—	—
GK. H1221 (E-100°)	—	—	82.0	51.0	0.62	—	0.50
GK. H1221 (E-280°)	—	—	35.0	23.6	0.67	—	0.52
Kera 401 (E-180°)	143.0	50.0 (.35)	55.0 (.38)	38.0 (.27)	0.64	1.55	0.58
for comparison							
BMNH. C13912	133.5	42.2 (.34)	55.2 (.41)	38.4	0.69	1.38	—
UCLA. 28656	73.0	25.0 (.34)	27.0 (.37)	16.0 (.22)	0.59	1.29	—
SAM. PCA 2749	90.0	25.0 (.28)	37.0 (.41)	39.0 (.45)	1.04	1.32	0.55

BMNH. C13912 = holotype of *A. dibleyi* (measured by T. M. in the deformed state).
UCLA. 28656 = holotype of *P. puma* (cited from Murphy and Rodda, 1960).
SAM PCA 2749 = one of "*A. dibleyi*" from Angola (cited from Cooper, 1978).

Observations:—The holotype is fairly large but its preserved last part is still septate. Several major ribs which frequently occur on its last part probably imply the beginning of the ornamentation of the mature or adolescent stage in *Austiniceras*.

GK. H1221 is incomplete but not distorted and shows fairly well some of the diagnostic characters, as shown in the illustrations. It is still septate and must have been similar to the holotype in size. Kera's 401 is deficient in its ventral part of the outer whorl, but is almost undistorted. It is again still septate and estimated nearly 250 mm in diameter of the restored phragmocone. Suture is finely exposed on a part of the outer whorl.

No example among the available specimens preserves completely the body-chamber. At least partly the surface of the body-chamber is smooth. So far, a dimorphic pair has not been fully recognized in this species and should be worked out in the future.

Comparison and discussion:—On the previous occasion (Matsumoto, 1954b, p. 78) this species was tentatively referred to *Puzosia,* although it was atypical at certain points.

As more descriptions have been given on the relevant species, we can now compare this species with them precisely. With respect to the shell-form, this species is fairly similar to *Puzosia puma* Murphy et Rodda (1960, p. 849, pl. 104, figs. 5—6), from the upper part (probably Cenomanian) of the Bald Hills Formation of California (see the dimensions of the holotype). That California species, however, does not show such a distinct ribbing as that of this species in the late growth-stage, although the constrictions and faint ribs on its inner whorl are fairly similar to those of our species.

This species resembles *Austiniceras dibleyi* Spath, 1922, as represented by the holotype (see

Kennedy, 1971, pl. 14, fig. 4; Wright and Kennedy, 1981, pl. 2, fig. 4) from the Upper Cenomanian of England, which one of us (T. M.) once examined at BMNH., in its shell-form and ribbing of the outer whorl. The former is distinguished from the latter by less frequent flares or constrictions on the earlier part and presence of more distinctly sigmoidal ribs; also the holotype and several other examples in our province are much larger, being nearly twice as large as the holotype and other examples of the British species (e.g. Sharpe, 1855, pl. 12, fig. 2; Wright and Kennedy, 1981, pl. 1, figs. 2a—c). Although the holotype of *A. dibleyi* is somewhat distorted secondarily and its right side is embedded in the matrix of chalk, the whorl is originally higher than broad and has moderately rounded venter as is better shown by BMNH. C10618 (Wright and Kennedy, 1981, pl. 1, figs. 2a—c).

The specimens from the Upper Cenomanian of Salinas, Angola, which were illustrated as *Austiniceras dibleyi* by Kennedy (1971, pl. 13, fig. 1) and described under *Puzosia* (*Anapuzosia*) *dibleyi* by Copper (1978, p. 78, figs. 11A, 14B—C, 15B—C), represent, in our opinion, another

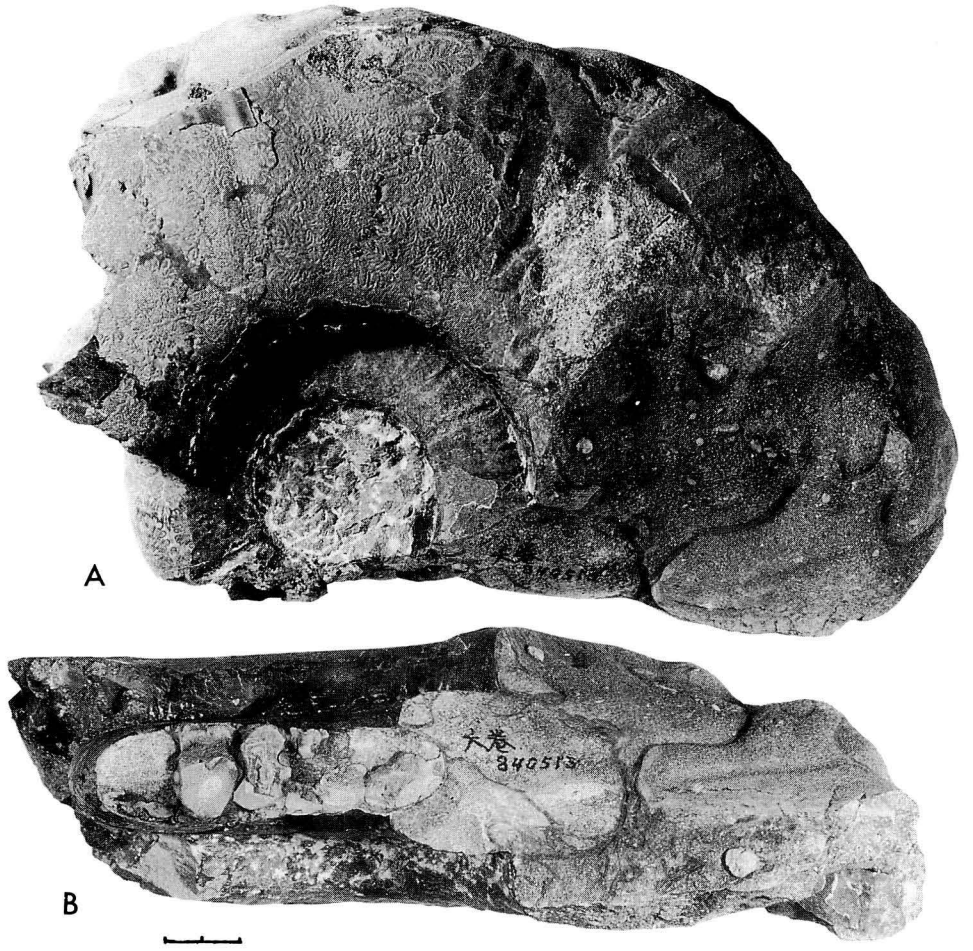


Figure 46. *Austiniceras nipponicum* (Matsumoto).
A—B: additional example, Y. Kera Coll. no. 401 from the Ohmaki-zawa, Oyubari area; scale bar = 20 mm.

distinct species which is characterized by broader and more rounded whorls and coarser and more sigmoidal ribs than those of true *A. dibleyi* from England. That Angola species is not *Austiniceras* and may be an atypical *Anapuzosia* or could possibly be immature *Pachydesmoceras*.

It may be worthy to note that the mode of ribbing on the outer whorl of *A. nipponicum* is similar to that of the Angola species in lateral view. The ribs and flares of the latter are coarser and stronger than those of the former on the whorl of corresponding size. The holotype and several other specimens of *A. nipponicum* are not secondarily deformed but originally compressed. Therefore, *A. nipponicum* is distinguished from the Angola species in its much compressed whorls, with much smaller ratios of B/H (0.60 to 0.67), nearly flat flank, which converge gently to the venter and subangular umbilical shoulder as compared with broader and more rounded whorls, with larger ratios of B/H (e.g. 0.97 to 1.06 in Cooper's measurements), convex flanks and rounded umbilical shoulder of the latter.

In our opinion, *A. dibleyi* is allied to *A. nipponicum*. Therefore, Spath (1922), Wright and Wright (1951) and Kennedy (1971) were correct in calling the British species *Austiniceras dibleyi*; also we should revise *Puzosia nipponica* to *Austiniceras nipponicum*. A question may remain whether the distinction between *A. dibleyi* and *A. nipponicum* is specific or subspecific. This should be worked out in the future.

Occurrence:—The main or lower part of Member IIb of the Abeshinai-Saku area, Teshio Mountains; Member IIk in the Shiyubari-Oyubari area, Yubari Mountains. Also from the horizon Kz-Mh, through Zone Mho, to the horizon Mho-Mhl, Naibuchi and Aikawa areas, South Sakhalin. Cenomanian (probably middle to upper part).

Genus *Bhimaites* Matsumoto, 1954

Bhimaites takahashii sp. nov.

(By T. Matsumoto)

Figure 47

Holotype:—GK. H8094 [=TTC. 440720] (Fig. 47), collected by Takemi Takahashi from a floated nodule in a small stream (called A-sawa) on the right side of the River Obirashibe at the conference with the tributary called Kami-kinembets, together with *Inoceramus hobetsensis* Nagao et Matsumoto. It was donated to and is kept in Kyushu University.

Besides the above holotype, a still smaller specimen, UMUT. MM 5624 [=GT. I-3101], mentioned and illustrated by Matsumoto and Obata (1955, p. 136, pl. 30, fig. 7) under *Desmoceras* (*Pseudouhligella*) (?) n. sp., from the Saku Formation of the Saku area is probably an immature example of this species.

Description:—The holotype is a fine specimen with test preserved for the most part and the body-chamber preserved for at least 180°. It is, however, small as measured below:

Diameter	Umbilicus	Height	Breadth	B/H
60.6 (1)	13.8 (.23)	27.8 (.46)	18.5 (.31)	0.67

Three fifths of the inner whorl is overlapped by the outer whorl. Expansion ratio per 180° in the outer whorl is 1.47 in whorl-height and also in radius. Umbilicus is fairly narrow.

The body-chamber is higher than broad, elongate oval in section, broadest at or a little dorsad from the mid-flank, with gently convex flanks and rather narrowly arched venter; umbilical wall

low but vertical and umbilical shoulder subangular. The septate whorl is much compressed, with B/H = 0.5 at its end, and its venter very narrow.

On the body-chamber narrow flares are frequent, 7 within a half whorl. They are somewhat prorsiradiate and gently flexuous on the main part of the flank and remarkably projected on the ventral part. The preserved last three of them run distinctly from the umbilical margin to the venter but others are weaker and discernible on the venter and the outer part of flanks. Flares are also discernible on the venter of the late part of the phragmocone. Their existence or absence is not observable on the inner whorl, for the ventral part is overlapped by the outer whorl.

On the shell surface there are weak and thin subcostae and finer lirae of unequal length. They run generally in parallel with the periodic flares, but some of them are somewhat more flexuous, showing a moderate projection at the inner lateral point, suggesting an absorbed lappet (parabole). This means that the holotype may represent a microconch, but its very last part with the apertural margin was regrettably lost.

The sutures are observable by means of slight etching through semi-transparent inner shell layer in the early part of the last whorl. They show asymmetrically tripartite large L, smaller U2 and very gradually descending auxiliaries.

Comparison:—The flares on the shell certainly correspond to the constrictions on the internal mould, as can be seen on some parts. Assuming that this is correct, the holotype of *B. takahashii* closely resembles that of *Bhimaites stoliczkai* (Kossmat) (Stoliczka, 1865, pl. 71, fig. 3), although the latter is an internal mould. In addition to Stoliczka's, more examples of *B. stoliczkai* have been described (see the indication in p. 20). They all show that *B. stoliczkai* has less compressed

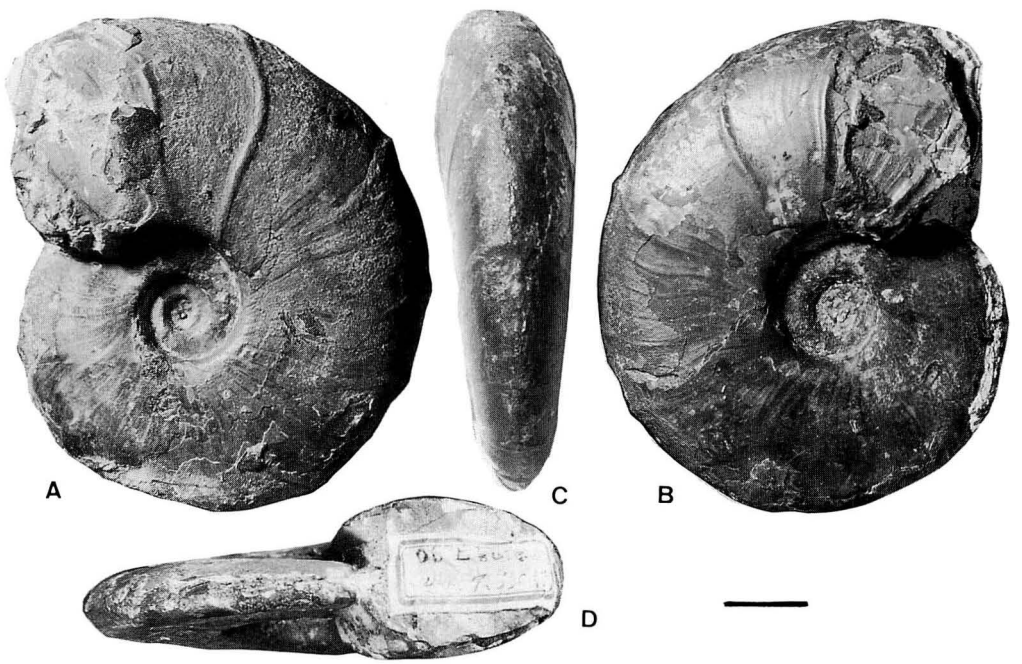


Figure 47. *Bhimaites takahashii* Matsumoto, sp. nov.
A—D: holotype, GK. H8094 from near the mouth of the Kami-kinembets, Zone of *Inoceramus hobetsensis*, Obirashibe Valley (Coll. T. Takahashi, 440720); bar = 10 mm.

whorls than *B. takahashii*. Especially in the immature stage this difference is great, for the latter is extremely compressed. Another distinction is in the shape of the whorl. In *B. stoliczkai* the whorl is broadest near the umbilical shoulder, as Renz (1972, fig. 7B) clearly illustrated, whereas in *B. takahashii* it is broadest at about (strictly speaking slightly dorsad of) the gently convex mid-flank.

To know the extent of variation of this species more specimens are wanted. To search for an example of macroconch of this species is another point to be worked out. Despite these drawbacks, I dare to establish here a new species, for more than 15 years have passed since T. Takahashi found this fine specimen.

Occurrence:—Rarely found in the Middle Turonian Zone of *Inoceramus hobetsensis* in the Obira and probably also the Saku areas, northwestern Hokkaido.

Genus *Pachydesmoceras* Spath, 1922

Pachydesmoceras denisonianum (Stoliczka)

(By T. Matsumoto, Y. Kawashita and T. Takahashi)

Figures 48—49

1865. *Ammonites denisonianus* Stoliczka, p. 153, pl. 66a.
1904. *Puzosia denisoni* (Stoliczka); Douvillé, p. 237, pl. 29, figs. 2, 4.
1914. *Puzosia denisoniana* (Stoliczka); Yabe, p. 82, pl. 12.
1954. *Pachydesmoceras* cf. *denisonianum* (Stoliczka); Matsumoto, 1954b, p. 100.
1961. *Pachydesmoceras denisoni* Stol.; Collignon, p. 39, pl. 8, fig. 1.
1985. *Pachydesmoceras denisonianum* (Stoliczka); Kaplan, Keller and Wiedmann, p. 322, pl. 7, fig. 1.
1987. *Pachydesmoceras denisonianum* (Stoliczka); Matsumoto, p. 5.

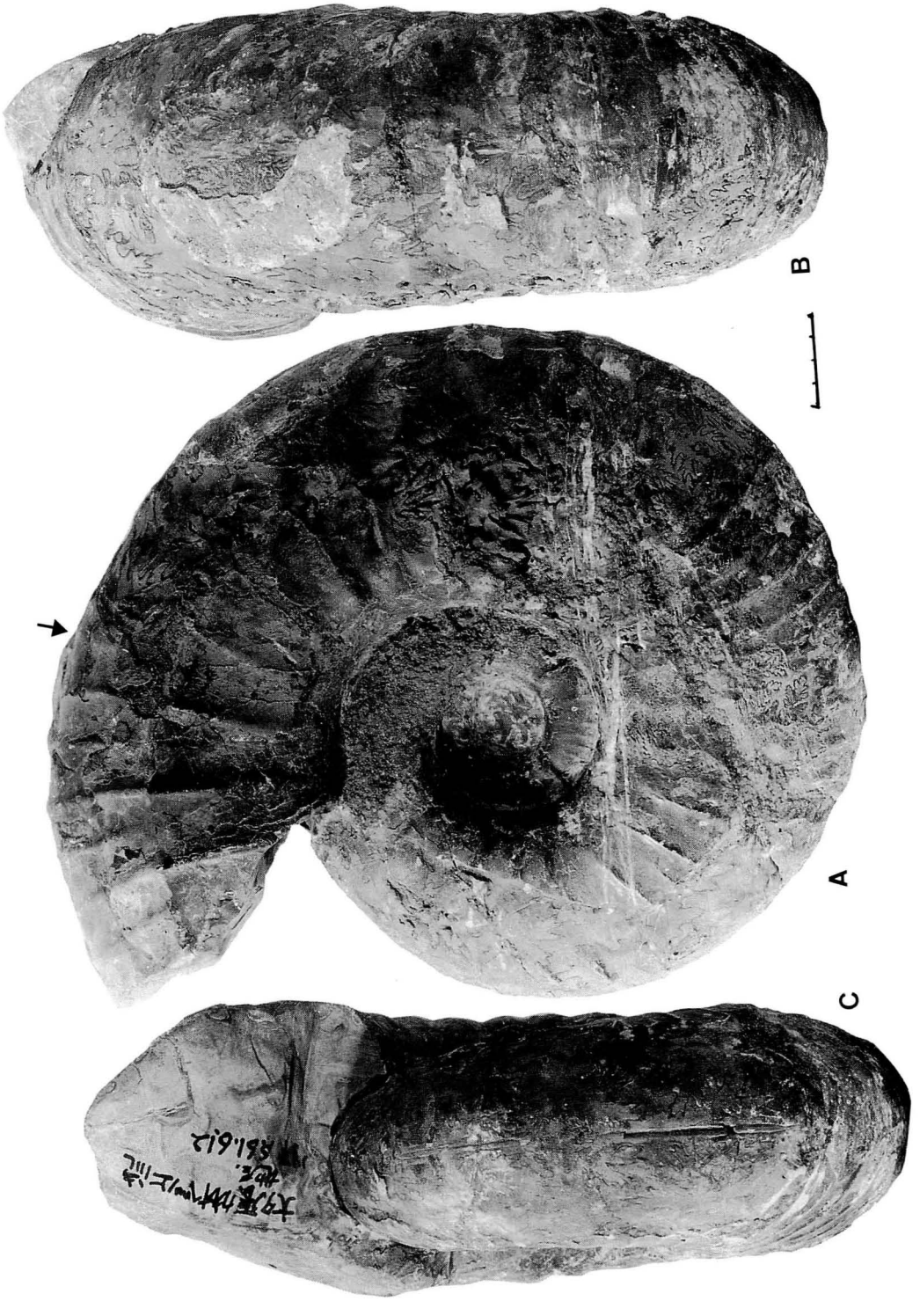
Lectotype:—GSI. 208, figured by Stoliczka (1865, pl. 66a), from the Uttattur Formation [Ootatoor Group], northeast of Odium, South India (designated by Matsumoto, 1987).

Material:—YKC. 610612 (Fig. 48) obtained by Y. Kawashita and T. Takahashi from loc. Y5311 of T. Matsumoto, cliff on the right side of the River Kaneobets, outcrop of mudstone referable to the upper part of the Cenomanian on the ground of stratigraphic position and the assemblage of foraminifera (identified by Dr. S. Maiya). GK. H1226 from loc. Y610, middle part of Member IIf, in the Shiyubari valley, adjacent to the northeast of the Oyubari area (Coll. T. M.); GSJ. F3469 (Fig. 49), collected by K. Tanaka and Y. Maeda from the Cenomanian mudstone of the Middle Yezo Group, exposed at a cliff on the River Sorachi in the Ashibetsu Park, Ashibetsu district.

Diagnosis:—Shell fairly large (in microconch) or huge (in macroconch), with low to moderate ratio of whorl expansion, low to moderate degree of involution and moderately wide umbilicus (U/D ranging from 0.31 to 0.41 in measured specimens). Whorls thickly ovoid or subcircular in section in late growth-stages, with rounded venter, convex flanks, abruptly rounded umbilical shoulder and steep umbilical wall.

Constrictions of moderate frequency on the inner whorls; long ribs begin to appear at fairly early substage of the middle growth-stage, i.e. at about 60 mm in diameter, being nearly rectiradiate on the exposed main flank of the inner whorls and gently curved forward toward the outer part.

At a later stage, i.e. on the late part of the phragmocone, the long ribs narrow but elevated and disposed at gradually broadening intervals where normally two unequally shorter ribs are intercalated. Constrictions not distinct and may be discernible as shallow furrows along some


B
A
C

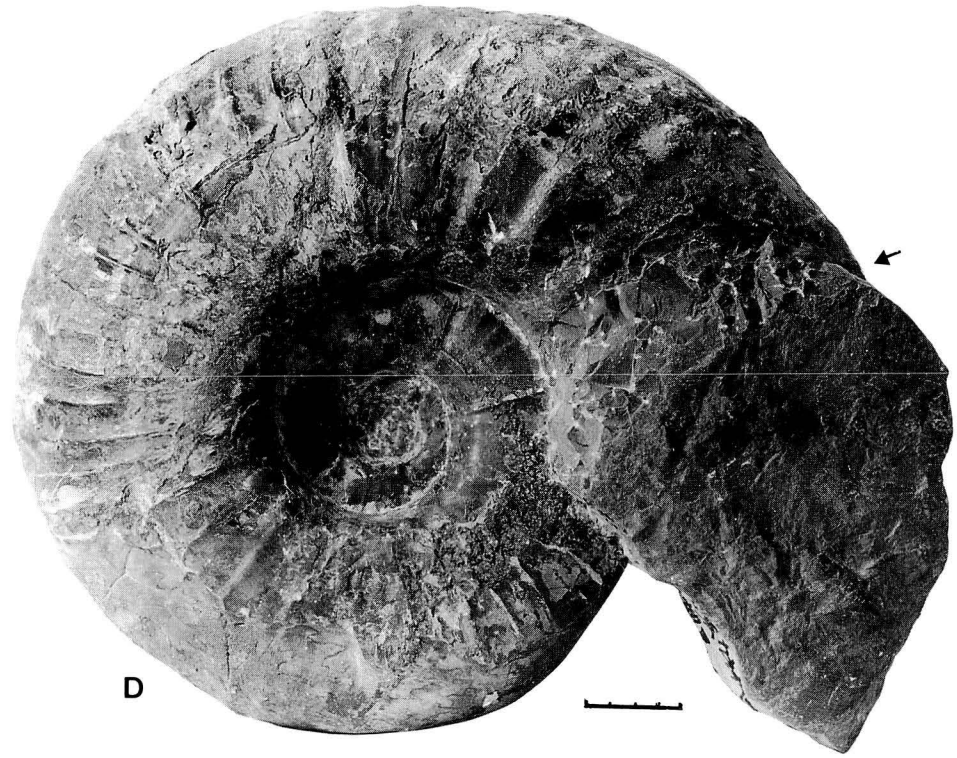


Figure 48. *Pachydesmoceras denisonianum* (Stoliczka).
A—D: very large specimen, phragmocone and a fraction of body-chamber, YKC. 610612 from loc. Y5311, the Kaneobets, Oyubari area (Coll. Y. Kawashita & T. Takahashi); scale bar = 40 mm.

of the long ribs. The long ribs nearly rectiradiate or slightly prorsiradiate on the inner flank and gradually curved forward on the ventrolateral part, crossing the venter with broadly convex curve, i.e. with a little projection.

In the adult shell the ribs become thicker and more distant than in the preceding stage, normally alternately long and short, gently arcuate on the main flank and gradually curved forward on the outer part. Main part of the body-chamber of a large form (probably macroconch) ornamented only with thick ribs disposed at wide intervals, broadening but lowering outward with gently concave curvature, fading away on the venter in the last part.

Suture of the same pattern as that of *Puzosia*.

Dimensions:—

Specimen	D	U	H	B	B/H	H/h	Inv.
Lectotype (LS+180°)	995 (1)	410 (.41)	345 (.35)	300 (.30)	0.87	1.44	
YKC. 610612 (LS+10°)	365 (1)	120 (.33)	143 (.39)	183 (.36)	0.93	1.40	0.43
GSJ. F3469	460 (1)	156 (.34)	179 (.39)	195 (.42)	1.09	1.43	0.37
Yabe, 1914*	446 (1)	142 (.32)	188 (.42)	160 (.36)	0.85	—	—
MNHN. 3750**	166 (1)	52 (.31)	67 (.40)	65 (.39)	0.97	1.43	0.42

* Yabe, 1914, pl. 12 (remeasured; B restored from less deformed left half.
** Collignon, 1961, pl. 8, figs. 1, 1a (remeasured).

Observations:—The lectotype is probably an adult macroconch, for it is huge, slightly more than 1080 mm in diameter at the preserved end of the body-chamber, which occupies about 240°, and the main part of the body-chamber is ornamented only with thick major ribs disposed at wide intervals. There are 18 ribs on the preserved body-chamber, i.e. 14 in a half whorl. The specimen is mounted on a plaster plate, because its right side is deficient. As its left half is well preserved, the whorl-breadth (B) can be approximately estimated but actually B and B/H may be somewhat larger than the estimated ones written in the table. The phragmocone is about 700 mm in diameter at its end.

YKC. 610612 is about 360 mm in diameter at the end of the phragmocone, and only a fraction (about 30°) of the body-chamber is preserved. It must have been at least 530 mm in diameter, when the body-chamber was complete, but this is much smaller than the lectotype. In its preserved last part, the alternately long and short ribs somewhat strengthen, being separated by gradually broadening interspaces; also the whorl is considerably rounded. These features suggest the beginning of the adult stage. Therefore, it may represent a microconch, which is about a half of the macroconch in diameter. We are, however, not confident of this interpretation and should search for the main part of the body-chamber as well as its apertural margin.

GSJ. F3469 is wholly septate but larger than YKC. 610612. It is thick-whorled and fairly deeply umbilicate, with high and steeply inclined or nearly vertical wall. The whorl-section at the preserved end is fairly broader than high, showing B/H = 1.21, but the last portion is somewhat disjuncted from the main part by a small-scale faulting and may be secondarily depressed. Even in the undeformed main part, the whorl is broader (B/H = 1.09) than those of other measured specimens. The venter is broadly rounded, the flanks are convex, with the maximum breadth at some distance from the mid-height toward the dorsum, and bent abruptly to the umbilical wall, forming a subrounded umbilical shoulder.

In the last portion behind the preserved end one short rib is intercalated between the two long ribs; in the preceding main part of the outer whorl for about 210°, two short ribs of unequal

length are intercalated between each two of the long ribs, there are 14 long ribs in a half whorl. This is the same frequency as that of the thick major ribs on the body-chamber of the lectotype. The longer ribs are somewhat more elevated than the shorter ones. In the still preceding part each interspace of the long ribs has three shorter ribs, of which the middle one is longer than the other twos, reaching the inner flank. A similar mode of ribbing seems to occupy the next inner whorl, where some of the longer ribs are stronger than others, representing probably periodic flares, which are of moderate or rather irregular frequency.

This GSJ specimen would be about 850 mm in diameter on the assumption that the preserved end is close to, if not precisely, the end of the phragmocone, that the succeeding body-chamber is at least 210° in spiral length, and that the ratio of U/D is kept 0.34. This is the minimum

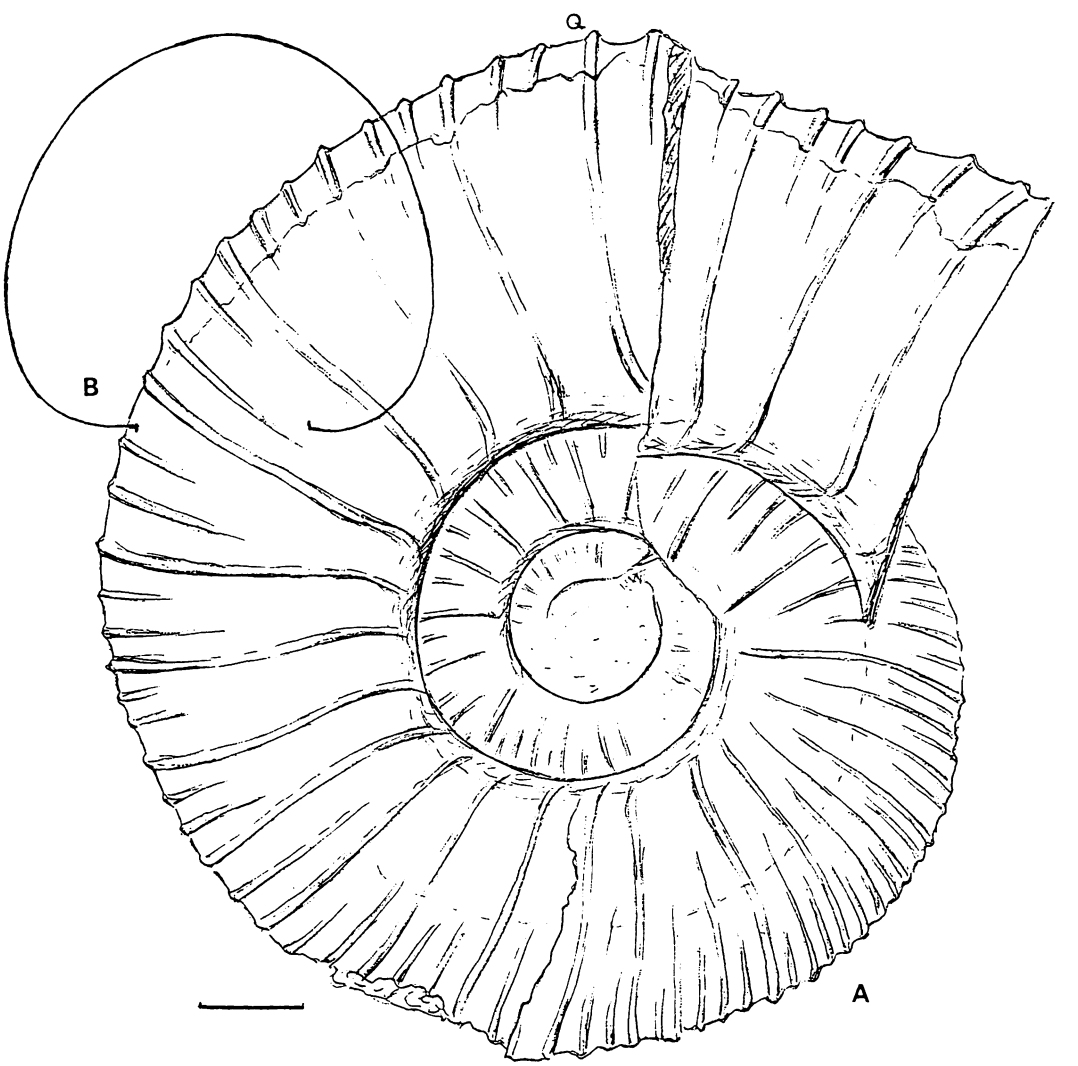


Figure 49. *Pachydesmoceras denisonianum* (Stocliczka).
A—B: phragmocone of a huge individual, GSJ. F3469 from the Ashibetsu Park (Coll. K. Tanaka and Y. Maeda); whorl-section (B) at Q in Fig. 49A; bar = 50 mm. (T. M. *delin.*)

estimation and, therefore, GSJ. F3469 may be the phragmocone of a macroconch. We should search for the body-chamber to examine whether it is similar to that of the lectotype or otherwise.

The ribs on the preserved last quarter whorl are fairly widely separated in GSJ. F3469 as measured below:

L, 25. S, 19, S, 21, L, 26, S, 18, S, 26, L, 26, S, 22, S, 29, L, 26, (disjuncted), S, 24, L, 30, S, 23, S, 29, L, 35, S, 23, L

where L = long rib, S = short rib, figure = distance in mm between the summits of the two adjacent ribs along the mid-venter.

In the same way the ribs on the first quarter of the preserved outer whorl are measured below, which are denser than those of the last quarter:

L, 9.6, S, 9.2, M, 9.2, S, 11.2, L, 11.4, S, 13.6, M, 11.6, S, 12.4, L, 10.8, S, 12.2, M, 13.0, S, 12.0, L, 10.4, S, 10.4, M, 10.8, S, 10.6, L, 13.2, M, 12.0, S, 14.8, M, 10.0, S, 12.0, L, 12.0, S, 12.0, S, 15.0, L

where M = rib of moderate length which reaches the inner flank but disappear there, without extending to the umbilical margin; others same as those explained above.

The specimens from the Cenomanian of Madagascar described by Collignon (1961, p. 39, pl. 8, figs. 1, 1a) are less than 180 mm in diameter but were regarded by Collignon as adult or middle-aged examples. They may be microconchs, although the evidence is again insufficient. MNHN. 3730, the figured specimen, shows the fairly crowded ribs of unequal length, being comparable in this point and in size with the inner whorls of the lectotype and GSJ. F3469. In that Madagascar specimen some of the long ribs (L) are accompanied with indistinct constrictions and show a little more projection on the outer part than other ribs.

The specimen from Oidaira in the valley of the Monobe-gawa, Kochi Prefecture (= Tosa), Shikoku, reported by Yabe (1914, p. 72, pl. 12), is a fragmentary piece of the outer whorl, about 150°—160° in spiral length. The ribs on its earlier part are narrow and alternately long and short; those on its later part are thick and fairly distant but still alternately long and short. It resembles YKC. 610612 (Fig. 48 of this paper) in its ribbing and is somewhat larger (D = 430 mm at the last suture in a restored outline, as compared with 360 mm of YKC at the corresponding position). As it is secondarily compressed, the ratio B/H = 0.85 and U/D = 0.32 in a restored outline may be still underestimated to some extent. As the adult type ribbing begins to appear near the last suture, it can be regarded as an incompletely preserved microconch of *P. denisonianum*.

Comparison and discussion:—When Spath (1922, p. 127) proposed the genus *Pachydesmoceras,* he designated the specimen illustrated by Kossmat (1898, pl. 15, figs. 5a, b and pl. 14, fig. 6) as the genotype. Renz (1976, p. 760) wrote this specimen as the holotype of *P. denisonianum*. These procedures are obviously inadequate on reference to the International Code of Zoological Nomenclature.

Since a genus should be established on a species and not on a particular specimen, the type species of *Pachydesmoceras* is *Ammonites denisonianus* Stoliczka, 1865. This species was established on several syntypes in which the above mentioned Kossmat's specimen of subsequent collection by H. Warth was not included. There are four syntypes illustrated by Stoliczka, who thought them as showing aspects of variation. They are kept at the Geological Survey of India (GSI), Calcutta, where one of us (T. M.) studied them in 1964.

Kossmat (1897—1898) was right in excluding the twos (Stoliczka, 1865, pl. 65, fig. 4; pl. 66, fig. 1) from the four syntypes to *Pachydiscus jimboi* Kossmat, 1898 and *Holcodiscus sparsicostatus* Kossmat, 1897, although the former is *Lewesiceras* or rather *Nowakites* (in T. M.'s view) and the latter *Kossmaticeras* in the current generic assignment.

The third syntype, GSI. 265 (Stoliczka, 1865, pl. 66, figs. 2, 2a) is wholly septate and not

large (D = 133 mm). Moreover, its locality record in the explanation of plate is doubtful and was thought erroneous by Kossmat. It is essentially similar to the middle to early late-aged shell of *P. kossmati* Matsumoto, 1987.

By way of these procedures, the fourth syntype of Stoliczka (1865, pl. 66a), GSI. 208, a huge specimen, which shows the characters of the phragmocone and body-chamber both, had to be designated as the lectotype of *Ammonites denisonianus*. (See Matsumoto, 1987, p. 5.)

The comparison of *P. denisonianum* in a revised sense with *P. kossmati* has been already written briefly (Matsumoto, 1987, p. 7) and will be given in more detail in the description of the latter.

As *P. denisonianum* was understood too much comprehensively, several forms which were referred to this species are now doubtful. For instance, the specimens from the "Lower Senonian" of Diego-Suarez, northern Madagascar, described by Boule *et al.* (1906, pl. 18, figs. 3—5; 1907, p. 1) under *Desmoceras* (*Puzosia*) *denisonianum* are all doubtful, because their characters deviate considerably from the above revised diagnosis. They may be transferred to more than one species, although it is difficult for us to give definitely their adequate specific names without dealing with the enough material from Diego-Suarez.

A large specimen from the Turonian (?) of Germany described by Zimmermann (1912, p. 542, pl. 26) under *Puzosia denisoniana* is similar to the lectotype in its little involution and fairly wide umbilicus, but the ribs on the main part of its body-chamber are rather rigidly rectiradiate than gently arcuate and the ornamentation of its phragmocone is not well known on account of weathering. Therefore it is better to call it *Pachydesmoceras* aff. *denisonianum*.

Another large specimen from the Lower Cenomanian of the Swiss Juras described by Renz (1976, p. 759, pl. 1, figs. a, b) under *Pachydesmoceras* aff. *denisonianum* has a narrower umbilicus at the end of the phragmocone, followed by a peculiar overhang of the posterior part of the body-chamber onto the umbilicus, a subangular instead of subrounded umbilical shoulder, and much weaker ribs as compared with *P. denisonianum* redefined above. Moroever, it has a ventrolateral row of knobs. It is something else on account of its peculiar features, although it may be related to *P. denisonianum* (see genus *Epipuzosia* nov. in p. 26).

A very large but incompletely preserved specimen, from the Upper Cenomanian Zone of *Metoicoceras geslinianum* zone, Plenus Marls of southern England, illustrated as *Puzosia* (*Puzosia*) cf. *odiensis* (Kossmat, 1898) by Wright and Kennedy (1981, p. 18, text-fig. 7), is not in our opinion the named species. It is very similar to the above mentioned Zimmermann's specimen in its major ribs which are nearly rectiradiate on the main flank of the body-chamber with forward bending on the outer part and alternated with shorter, outer ribs. The whorl shape may have been modified by secondary compression. It would be better to call this specimen *Pachydesmoceras* (?) sp. or *P.* (?) aff. *P. denisonianum*. Large but secondarily distorted specimens from the same zone of Germany (Kaplan and Schmid, 1983, figs. 13—16; Kaplan *et al.* 1985, pl. 7, fig. 1) can be called *P.* cf. *denisonianum* (Stoliczka).

Pachydesmoceras alimanestianui (Popovici-Hatzeg, 1899), from the Upper Albian or Lower Cenomanian of Roumania, and *P. kamerunense* (von Koenen, 1898), from the Lower Turonian of southern Camoroons, were regarded by some authors as synonyms of *P. denisonianum*. We would regard them as independent species. We shall discuss the former in the description of *P.* aff. *kossmati* Matsumoto and we follow Reyment (1955) as to the latter.

Occurrence:—The lectotype was obtained somewhere in the Uttattur Formation, which ranges in age from late Albian to early Turonian. There is no reliable record to decide its precise

stratigraphic position, but we expect that it may have come from the lower or middle part of the Uttattur, i.e. Upper Albian or Cenomanian. This should be examined by further field work in the area northeast of Odium.

The specimens from Hokkaido enumerated in *Material* are all from the middle part of the Middle Yezo Group and Cenomanian in age. The specimen from Oidaira of Shikoku reported by Yabe (1914) should be Albian according to Prof. M. Tashiro who is doing a precise field work in the Cretaceous area along the River Monobe-gawa.

Pachydesmoceras kossmati Matsumoto

(By T. Matsumoto, M. Kera, T. Takahashi, Y. Kawashita and K. Muramoto)

Figures 50—54

1865. *Ammonites denisonianus* Stoliczka (pars), p. 153, pl. 66, figs. 2, 2a.
1898. *Desmoceras (Puzosia) denisonianum* (Stoliczka); Kossmat, p. 121, pl. 15, figs. 5a, b; pl. 14, fig. 6.
1922. *Pachydesmoceras denisonianum* (Stoliczka); Spath, p. 127.
1987. *Pachydesmoceras kossmati* Matsumoto, p. 6, fig. 1.

Holotype:—The specimen in Warth Collection, GSI., illustrated by Kossmat (1898, pl. 15 [21], fig. 5a, b: pl. 14 [20], fig. 6), from Odium, Uttattur Formation (probably upper part ?) of South India (designated by Matsumoto, 1987, p. 6).

Paratypes:—(1) The young specimen from India illustrated by Kossmat (1898, pl. 14 [20], figs. 5, 5a); (2) no. 398 of M. Kera's Coll. (Fig. 50) from a floated nodule of the Kaneobets, 2 km upstream from the conference with the Shuparo lake, and (3) TTC. 500622 (Fig. 51) of T. Takahashi's Coll. from loc. Y. 5201 on right side of the Hakkin-zawa, both Oyubari area (macroconch); (4) YKC. 600609—1 (Figs. 52A—B; 53C) (middle-aged) from the Obira area and (5) YKC. 560818 (Figs. 52C, 53A—B) from the *Yubariceras* bearing member of the southern branch of the Isojiro-zawa, Oyubari area, both Y. Kawashita's Coll. and (6) MC. Ob 00102p (Fig. 54) of the Muramotos' Coll. from the Nambu-zawa, Obira area (5 and 6 probably microconchs); (7) GSI. 265 from South India (Stoliczka, 1865, pl. 66, figs. 2, 2a).

Diagnosis:—Microconch medium-sized; macroconch large, at least twice as large as the microconch in diameter. Shell fairly involute and fairly narrowly umbilicate with moderate to rather high rate of whorl expansion.

Young shell, e.g. less than 50 mm in diameter, compressed, frequently constricted with associated narrow flares, and nearly smooth on the interspaces, but for very fine lirae which may be discernible on the shell surface, and then fine riblets appearing on the outer part of the whorl.

In the shell of middle growth stages, from about 60 mm to 125 mm in diameter of microconch, whorl broadened gradually but still higher than broad and suboval in cross-section, with somewhat convex flanks and subrounded umbilical shoulder; ornamented with long major ribs developed from frequent flares and several weak subcostae (earlier) or narrow minor ribs (later) of unequal length on each interspace of major ribs. The major ribs prorsiradiate, nearly straight or gently sigmoid on the main part of the flank and curved considerably forward on the outer flank, crossing the venter with marked projection. The minor ribs generally similar to the major ones in curvature but shorter, fading away in the middle or inner part of flank. Major ribs or flares 9 or more per whorl and may be associated by narrow constrictions at the

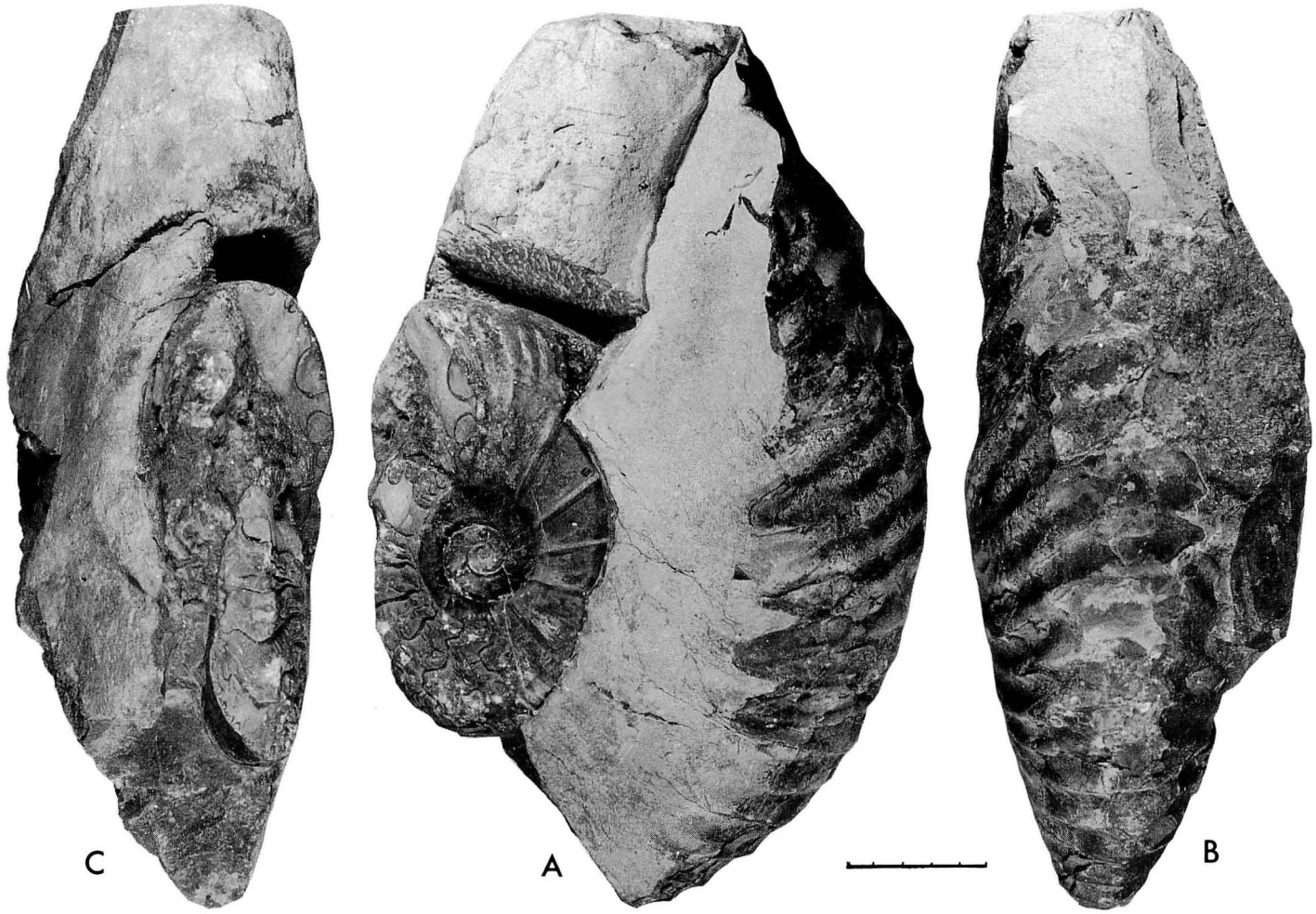


Figure 50. *Pachydesmoceras kossmati* Matsumoto.
A—C: paratype (2), adult macroconch showing also inner whorls, M. Kera Coll. no. 398 from the Kaneobets, Oyubari area; scale bar = 50 mm.

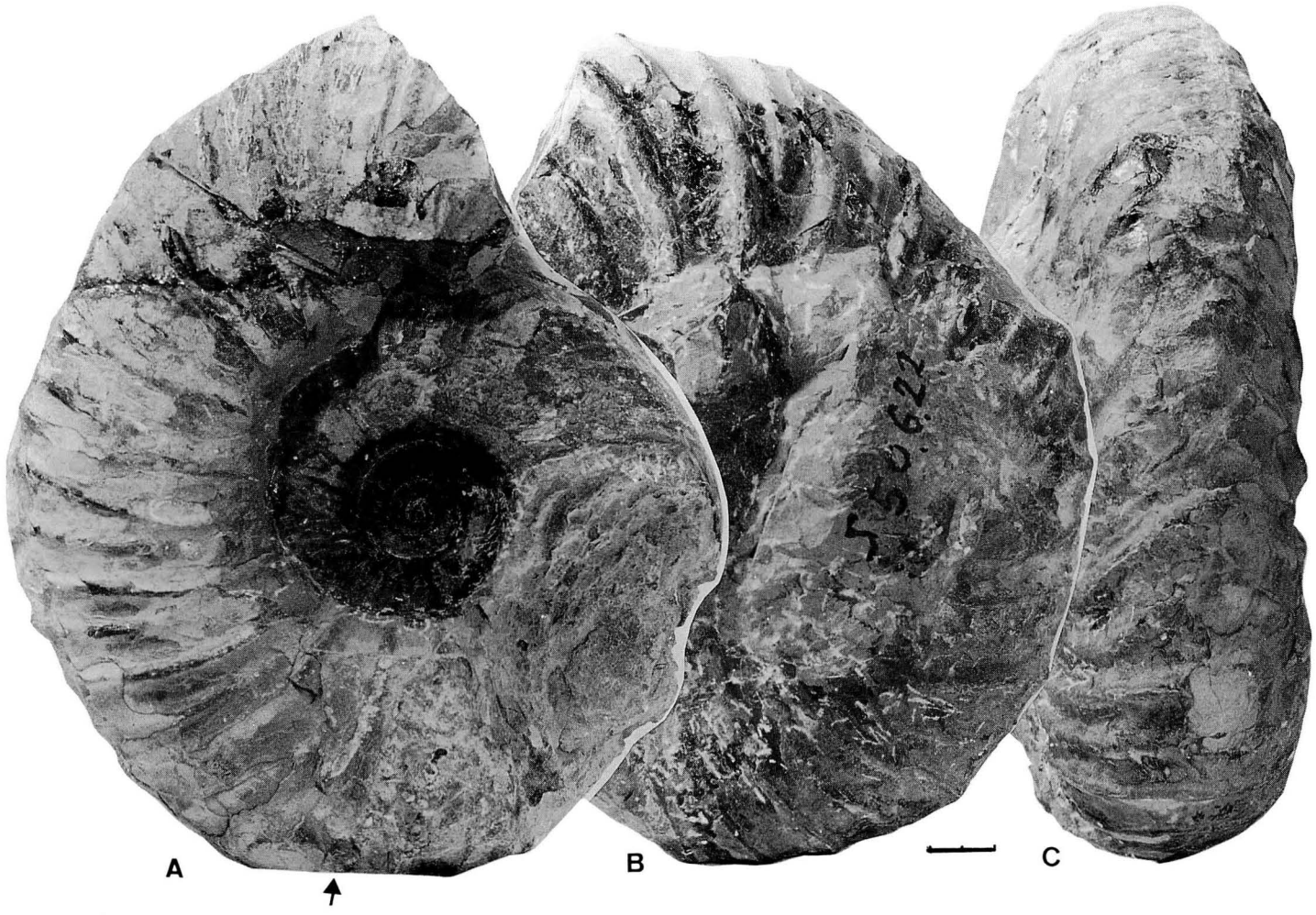


Figure 51. *Pachydesmoceras kossmati* Matsumoto.
A—C: paratype (3), adult macroconch, TTC. 500622 from the Hakkin-zawa, Oyubari area (Coll. T. Takahashi); scale bar = 20 mm.

early substage of the middle growth-stage.

Whorl of the adult stage slightly higher than broad or nearly as high as broad, broadly suboval in section with inflated flanks, broadest at a point somewhat dorsad of the mid-flanks; ribs gradually thicken and strengthen but of unequal length. At first two or three shorter ribs may occur on each interspace between the longer and somewhat stronger major ribs; finally long and short ribs normally alternated, both nearly equally strong, thick and fold-like on the outer part. These ribs of the adult whorl simply arcuate (i.e. concave) on the flank, passing gradually to the ventral projection.

Suture of the same pattern as that of *Puzosia*.

Dimensions:—

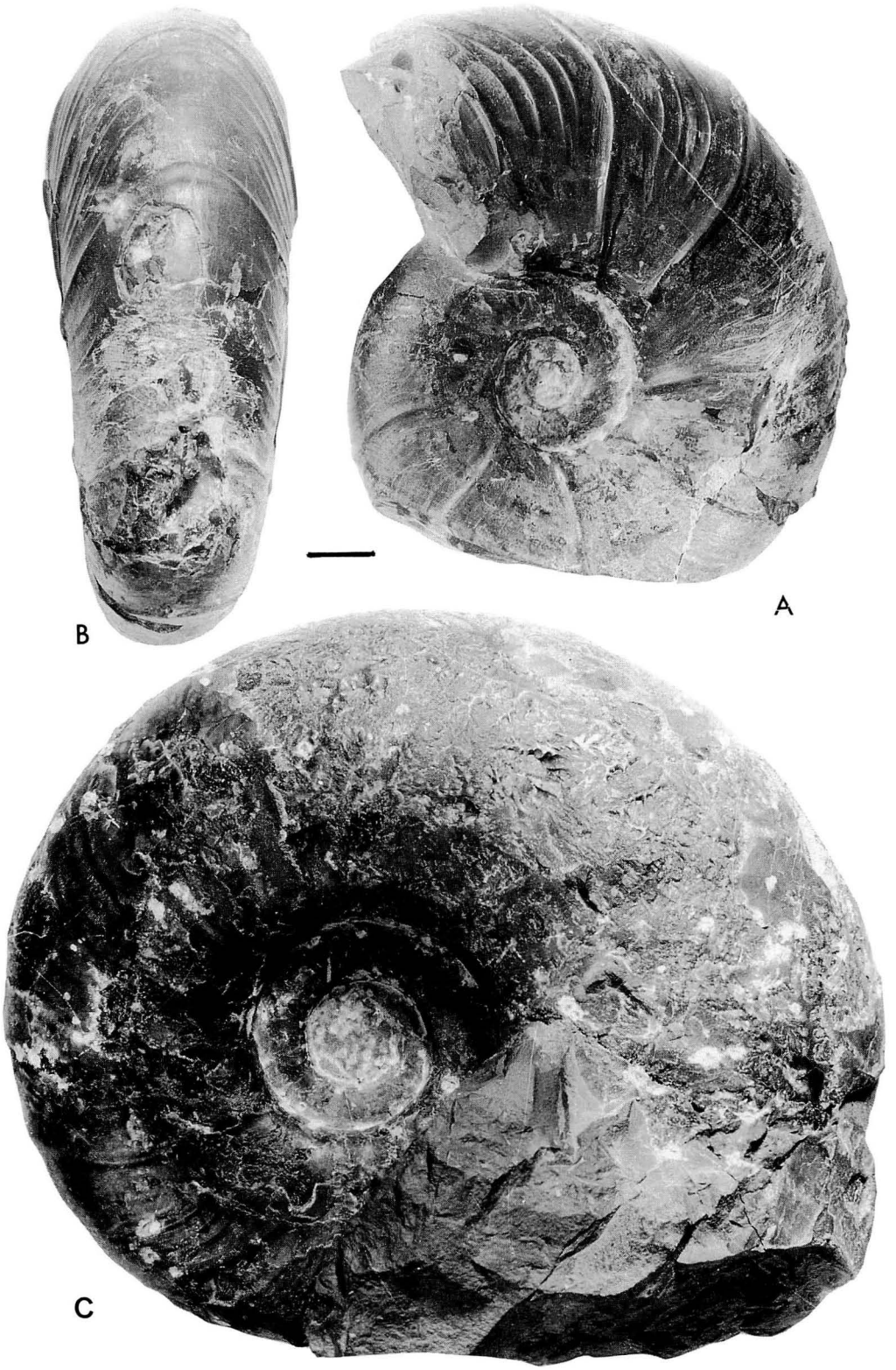
Specimen	D	U	H	B	B/H	H/h
Holotype	168.0	47.0 (.28)	71.0 (.42)	67.0 (.40)	0.94	1.42
Paratype (1)	55.0	14.0 (.25)	25.0 (.45)	19.0 (.35)	0.76	1.56
Paratype (2) inner	163.0	42.5 (.26)	73.0 (.45)	68.0 (.42)	0.93	1.54
Paratype (2) outer	350.0	98.0 (.28)	156.0 (.44)	—	—	1.62
Paratype (3) deformed	*c.* 267.0	*c.* 86.5 (.32)	*c.* 99.0 (.37)	*c.* 83.0 (.31)	*c.* 0.84	*c.* 1.21
Paratype (3) LS	—	—	80.5	76.0	0.94	—
Paratype (4) (E-90°)	84.0	23.0 (.27)	37.2 (.44)	32.4 (.39)	0.87	1.50
Paratype (5)	136.0	38.0 (.28)	60.0 (.44)	54.0 (.40)	0.90	1.58
Paratype (6)	123.0	34.0 (.28)	55.0 (.45)	52.5 (.43)	0.95	1.62
Paratype (7)	133.0	37.5 (.28)	55.5 (.42)	54.0 (.41)	0.97	1.35

Observations:—The holotype has alternately long and short, strong ribs on the body-chamber and can be regarded as an adult shell. Its diameter is about 170 mm in a restored outline. Paratype no. 2, i.e. Kera's no. 398, is likewise an adult example but its diameter is about 350 mm in a restored outline, being twice as large as the holotype. This remarkable contrast in size certainly implies the presence of dimorphism in this species.

Paratype no. 3 (TTC. 500622) is another example of macroconch. It is about 190 mm in diameter at the end of the phragmocone. The preserved half whorl of the body-chamber shows the adult type ornament. Should the body-chamber be as long as 240°, the entire shell diameter would exceed 300 mm.

Paratype no. 5 (YKC. 560818) shows the middle-aged type ribbing up to the diameter of about 125 mm. This is followed by stronger and coarser ribbing of the adult type, although only a fraction of the body-chamber is preserved in this specimen. It is probably a microconch. Paratype no. 6 also shows the ribbing of the middle-aged type up to the diameter of 120 mm and then the ribs begin to be coarser and stronger. Although the main part of the body-chamber is unpreserved, this specimen is probably another microconch. We notice that the minor ribs on the interspaces between the major flares at certain substage of the middle stage in the paratype (4) are somewhat finer and more numerous than those at the corresponding substage in the paratype (6), but this can be regarded as a variation within a species. The paratype (4) shows the characters of still younger stages and can be connected with the paratype (1), i.e. the available youngest specimen which was described by Kossmat.

GSI. 265 from India is doubtful or erroneous as to its locality record. According to the note by T. M. (who examined it), it is wholly septate but begins to show the adult type ribbing on the preserved last quarter whorl and the preceding three quarters of the outer whorl shows the ribbing of the middle-aged type, although the change of ribbing is gradual. Anyhow, it probably


A
B
C

represents the phragmocone of a microconch. In fact it is essentially similar to the paratypes (5) and (6) from Hokkaido, although it shows a somewhat lower rate of whorl expansion than that of the comparable two specimens.

The holotype does not preserve the entire outer whorl, but the measurements on the restored outline indicate a moderate rate of whorl expansion. It shows an abrupt forward bend of a flare at a certain point of the middle growth-stage, but this is a character which occurs occasionally. Normally, ribs are curved gradually forward on the outer part.

Comparison and discussion:—This species is distinguished from *P. denisonianum* in its higher rate of whorl expansion, deeper involution and narrower umbilicus.

The periodic flares of *P. kossmati* are more frequent but narrower and retained for a longer period from the early to middle growth-stage than those of *P. denisonianum*. The ribs and flares of the former are inclined and curved more remarkably forward than those of the latter.

The body-chamber of *P. kossmati* has alternately long and short strong ribs, in both micro- and macroconchs. *P. denisonianum* has similarly alternated strong ribs on the late part of the phragmocone and such a ribbing may persist to the early part of the body-chamber, but the main part of the body-chamber of the macroconch as represented by the lectotype has distant and thick major ribs which broaden and lower outward fading away on the venter.

The above is the general morphological distinction between *P. kossmati* and *P. denisonianum*. Within the population of *P. kossmati* from the Turonian of Hokkaido, we see a few exceptional features. For instance, the paratype (3) has a somewhat wider umbilicus and an exceptionally lower ratio of whorl expansion among other specimens from Hokkaido. As its outer whorl is considerably distorted secondarily, the measured value are not precise but may give us approximate dimensions of the outline. In other words this specimen may suggest some affinity between *P. kossmati* and *P. denisonianum* manifested on the shell-form. Its ornamentation of both inner and outer whorls is undoubtedly of *P. kssmati* type. To know the relationship of the two species which may be revealed on the ornamentation, more specimens are wanted especially for *P. denisonianum*.

A large phragmocone from the upper Chitina valley of Alaska, which was described by Matsumoto (1959a, p. 61, pl. 26, fig. 1; pl. 27, figs. 1a, b; text-fig. 9) under *Pachydesmoceras* sp. indet, is similar to the phragmocone of a macroconch of *P. kossmati* in the shell-form, but its constrictions or flares are not so frequent as those of *P. kossmati* and its dense and weak minor ribs persist up to the preserved last part where major ribs become frequent. That Alaskan specimen came from loc. USGS Mes. loc. 25441 in the sequence from Albian to Cenomanian.

We agree with Reyment (1955, p. 19) in regarding *P. kamerunense* (von Koenen, 1898), from the Lower Turonian of the southern Cameroons, as independent of *P. kossmati* (which was included in *P. denisonianum* at that date) in its straighter and finer ribs on the main flank and less forward bend on the outer part; also in that many of the ribs, both prominent major ones and intercalated weaker ones, are long, reaching the umbilical margin.

Whether the holotype of *Pachydiscus linderi* de Grossouvre, 1894 (p. 188, pl. 18), from the "lower Senonian" of France is *Pachydesmoceras* or a pachydiscid is hardly decided, because

← Figure 52. *Pachydesmoceras kossmati* Matsumoto.
Paratypes (4) and (5); A—B: YKC. 600609—1, showing characters of comparatively younger stage, from the Obira area; C: YKC. 560818, middle-aged shell, from the Isojiro-no-sawa, Oyubari area (both Coll. Y. Kawashita); bar = 10 mm.

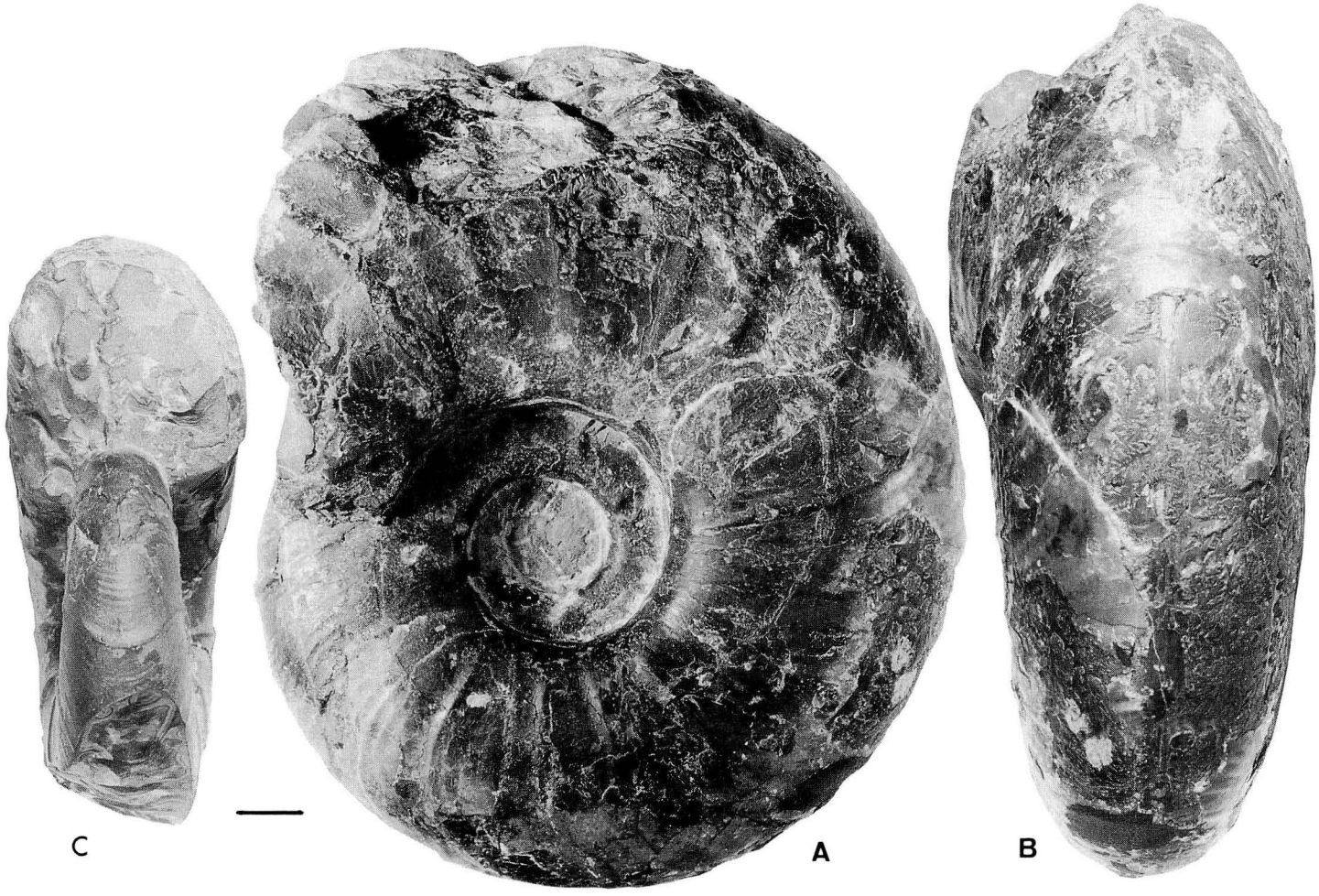


Figure 53. *Pachydesmoceras kossmati* Matsumoto.
Paratypes (5) and (4); A—B: same as Fig. 52C; C: same as Fig. 52A—B; bar = 10 mm.

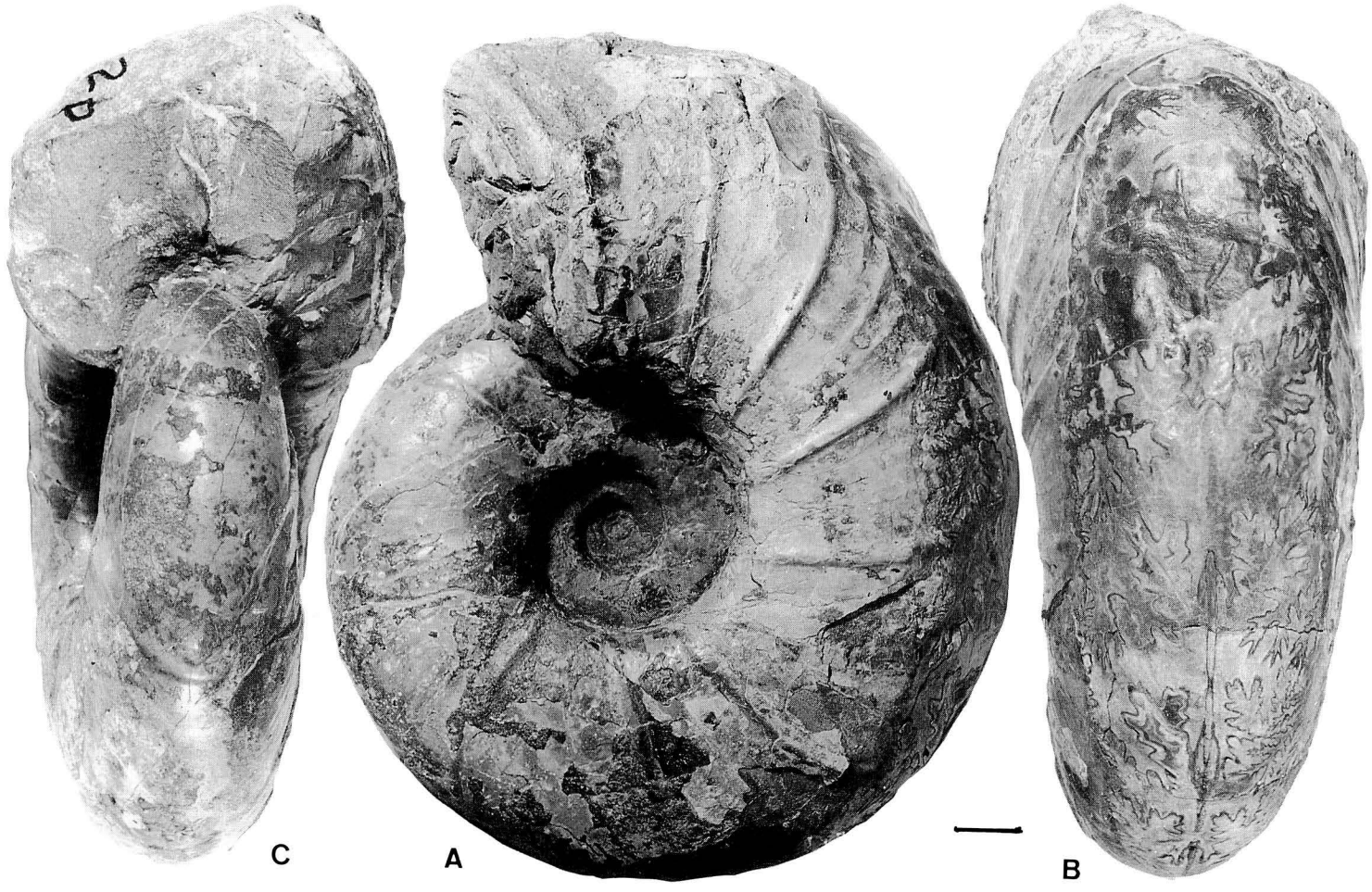


Figure 54. *Pachydesmoceras kossmati* Matsumoto.
A—C: paratype (6); middle aged shell, MC. Ob 00102 from the Obirashibe Valley (Coll. K. Muramoto); bar = 10 mm.

it is distorted, its inner whorl obscure and its suture unknown. What Collingnon (1961, 1965a) called *Pachydesmoceras linderi* from the upper Middle or Upper (?) Turonian of Madagascar may be correct in generic assignment, although the suture was not clearly figured. This species is similar to *P. kossmati,* but its adult whorl is less involute, somewhat more widely umbilicate and ornamented with more narrowly raised ribs as compared with that of *P. kossmati.* For the same reason, the specimen from the Middle Coniacian Zone of *Barroisiceras onilahyense* of Madagascar illustrated by Collignon (1965b, pl. 442, fig. 1752) under *P. denisonianum* is not *P. kossmati* but probably *P. linderi* of his sense.

Occurrence:—The lectotype was in a brownish calcareous nodule near Odium, which was interpreted by Kossmat (1898) as of upper Uttattur Formation with a query. In other words an early Turonian age is suggested for this species in South India.

Judging from the locality records, the specimens from Hokkaido described in this paper

Figure 55. *Pachydesmoceras* aff. *kossmati* Matsumoto.
A—C: YKC. 551005, from the upper reaches of the

are referred to the lower to middle part of the Turonian. To know more precisely the stratigraphic range of this species in Japan, further field works are necessary.

Pachydesmoceras aff. *kossmati* Matsumoto

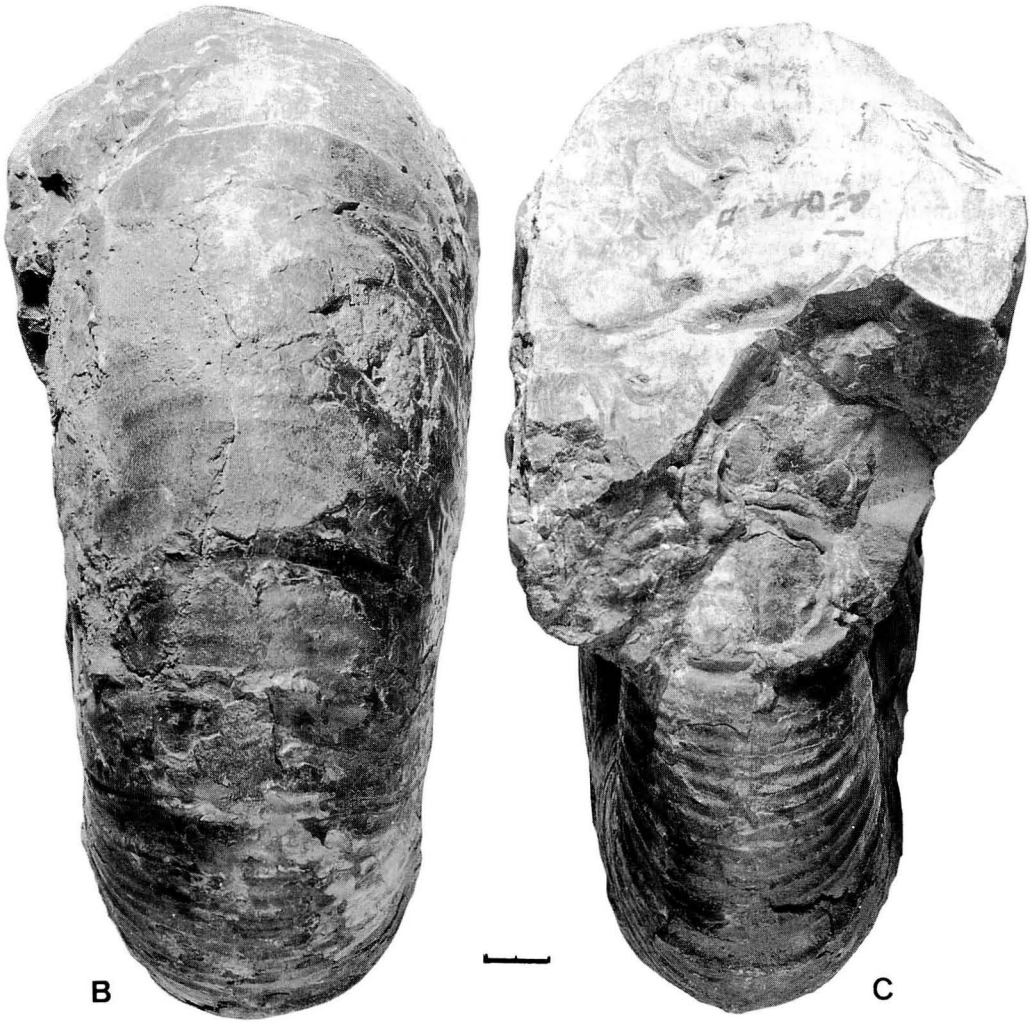
(By T. Matsumoto, T. Takahashi and Y. Kawashita)

Figure 55

Compare:

1987. *Pachydesmoceras kossmati* Matsumoto, p. 6, text-fig. 1.
1988. *Pachydesmoceras kossmati* Matsumoto; this paper, p. 116, figs. 50—54.

Material:—YKC. 551005 (Fig. 55) obtained by Y. Kawashita from the left (i.e. eastern) branch



Obirashibe River (Coll. Y. Kawashita); scale bar = 20 mm.

in the uppermost reaches of the River Obirashibe, probably Member Mg or Mh of K. Tanaka (1963; also *in* Igi *et al.*, 1958); TTC. 580919 obtained by T. Takahashi from a boulder of the Hakkin-zawa, near the outcrop of loc. Y5240, Oyubari area (see Hirano *et al.*, 1977, fig. 2 for the location).

Description:—YKC. 551005 is 280 mm in diameter at the measurable point of the septate whorl, which represents probably a middle aged shell. It was followed by an outer whorl for about 270° as evidenced by the trace of umbilical seam, which may have been occupied by the body-chamber for at least 210°. The entire shell would have been about 500 mm when the body-chamber was preserved.

In the middle aged shell whorl is fairly involute, about three fifth of the inner whorl being overlapped by the outer one, subcircular in cross-section, with evenly rounded venter, convex flanks and rounded umbilical shoulder, broadest at about the mid-height and nearly as broad as high. The umbilicus is fairly narrow and deep.

The shell is ornamented with frequent and narrow flares, 8 per whorl, with associated narrow constrictions, and numerous ribs of unequal length, some 12 to 7 on each interspace of the flares, crowded and normally alternately long and short. The flares and other long ribs are somewhat prorsiradiate on the inner flank and gently curved forward on the outer part; the shorter ribs are in parallel with them on the outer part; they all cross the venter with a broadly convex curve. On the preserved last part, although somewhat weathered, shows a thicker major ribs, suggesting the beginning of the adult type ornament.

TTC. 580919 is somewhat larger than YKC. 551005. It is somewhat deficient but similar in shell-form to the latter, having a fairly involute whorl which is subcircular in cross-section and slightly broader than high. The ornament of the early half of its preserved last outer whorl is quite similar to that of the above described specimen, then the ribs become gradually coarser. This is soon followed by the later part on which thicker ribs, alternately long and short, are characteristic. They are gently concave on the flank as shown on the preserved part. Some of the long ribs seem to be stronger than others, being probably a development from the periodic flares of the middle stage, although constrictions disappear in this later part, which is still septate at the preserved end. In other words the ornament of the body-chamber is not known. We could presume, however, either the widely separated, thick major ribs only as those on the body-chamber of *P. denisonianum* or the alternated long and short ribs persisting there but probably with wider intervals than those on the body-chamber of *P. kossmati.*

Dimensions:—

Specimen	D	U	H	B	B/H	H/h	Inv.
YKC. 551055	280.0	78.0 (.28)	123.0 (.44)	123.0 (.44)	1.00	1.56	0.64
YKC. 551005 −90°	241.0	66.0 (.27)	107.0 (.44)	105.0 (.44)	0.98	1.55	0.59
TTC. 580919	388.0	98.0 (.25)	166.0 (.43)	—	—	—	—
TTC. 580919 −270°	—	—	94.0	104.0	1.11	—	—

Comparison and discussion:—The two specimens probably represent a species which is allied to *P. kossmati* described above but dissimilar in its more circular and somewhat broader whorl already in the middle growth-stage, less frequent constrictions or flares in young stage, delayed and persistent appearance of the ornament characterized by frequent flares and crowded, numerous ribs of unequal length up to the diameter of 270 mm or so, and less projection of the ribs on

the outer part. The periodic flares are more frequent and numerous in the middle aged shell of *P. kossmati.*

With respect to the fairly involute and rounded whorl and numerous, narrow ribs, this species is similar to *P. alimanestianui* (Popovici-Hatzeg) (1899, p. 14, pl. 14, fig. 1), from the "Lower Cenomanian" of Roumania, but the latter does not show distinct flares, which if present, do not seem so frequent as those in ours. The body-chamber is not known either in that species.

As the characters of the body-chamber is not known in the two specimens from Hokkaido, we call them tentatively *Pachydesmoceras* aff. *kossmati.*

Occurrence:—Probably upper part of the Cenomanian in the Obira and Oyubari areas.

Pachydesmoceras pachydiscoide Matsumoto

(By T. Matsumoto, Y. Kawashita and K. Muramoto)

Figures 56—60

1954b. *Pachydesmoceras pachydiscoides* (*sic.*) Matsumoto, p. 101, pl. 9, figs. 2a, b.
1958. *Pachydiscus rosewoodensis* Anderson, p. 222, pl. 31, fig. 1.
1959b. *Pachydesmoceras pachydiscoide* Matsumoto; Matsumoto, p. 22, text-fig. 7.
1961. *Pachydesmoceras pachydiscoide* Matsumoto; Collignon, p. 42, pl. 12, fig. 1.

Holotype:—UMUT. MM 6660 [=GT. I-2805] (Matsumoto, 1954b, p. 101, pl. 9, figs. 2a, b), M. Kawada's Coll. from the Miho Group, South Sakhalin (by original designation).

Material:—Paratypes from Zone Mh 2 and Zone Mh 3 of the Miho Group of the Naibuchi Valley (Coll. T. Matsumoto), UMUT. MM 6661 [=GT. I-2716] to MM 6663 [=GT. I-2718], are regrettably missing at present. UMUT. MM 6666 [=GT. I-3207], labelled as *P.* cf. *pachydiscoide* from loc. T72a, Saku Formation of the Saku area (T.M. Coll.) is available.

The representative specimens in the subsequent collections illustrated or measured in this paper are as follows: (1) GK. H5794 (Fig. 56) from loc. T1092p, obtained by a field work team of 1960 by T. Matsumoto, H. Okada, Y. Orita and T. Muramoto, probably middle part (IId 2) of the Saku Formation of the stratotype Saku area (see Matsumoto and Okada, 1973, text-figs. 3 and 5 for the location and stratigraphic section); (2) YKC. 590513 (Fig. 57), collected by Y. Kawashita from a small stream called the Kashima-shogakko-no-sawa, Member Uy 1 (Coniacian) of Nagao *et al.* (1954) of the Oyubari area, and donated to and now kept at the Public Hall of Mikasa City; (3) a huge specimen, MCM. A92-581021-1, collected by Y. Kawashita from the head-waters of a branch of the Hinata-zawa, tributary to the River Shiyubari, correlative of the Saku Formation (Turonian, see Matsumoto 1942—43), northerly adjacent to the Oyubari area; (4) another huge specimen (Figs. 59, 60) temporarily on display at MCM in 1986, private collection of Kanichi Morita from a mudstone outcrop of the forestry road along the Kaneobets, Oyubari area; (5) YKC. 570530 (Fig. 58) collected by Y. Kawashita from the outcrop of the forestry road along the Kami-kinembets, (upper to middle Turonian), Obira area, donated to Mikasa City and now kept at the Office of the Mayor of Mikasa; (6) YKC. 590710, a huge specimen collected by Y. Kawashita from the Shirochi Formation (Upper Turonian) of the Karasemi-zawa, small branch of the Shirochi-une-zawa, upper reaches of the River Haboro (see Matsumoto and Toshimitsu, 1984, p. 340 and fig. 1 for the stratigraphy).

Diagnosis:—Microconch fairly large; macroconch huge. Shell fairly involute, about 55 to 65 percent (in whorl-height) of the inner whorl being overlapped by the outer one; rate of whorl

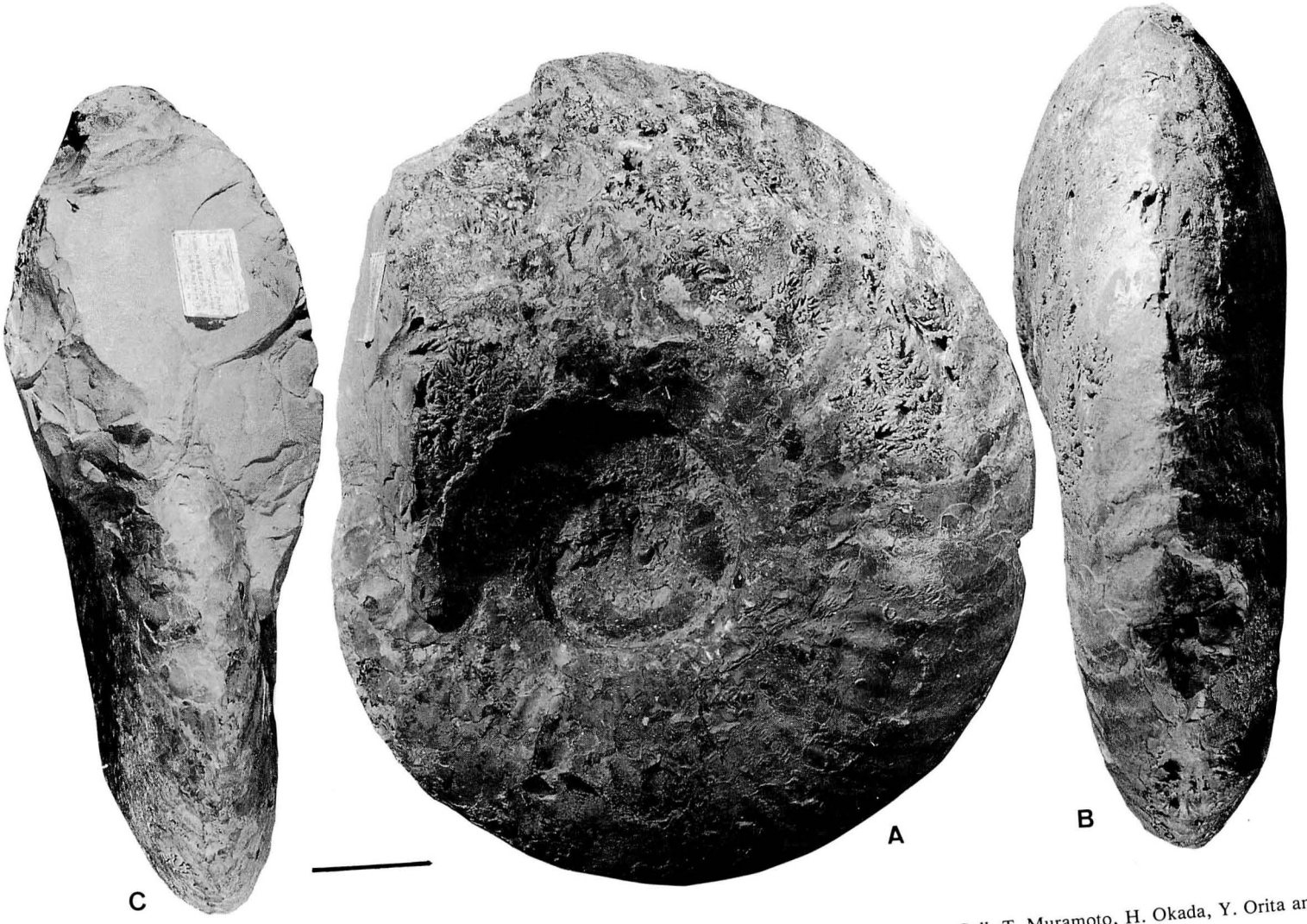


Figure 56. *Pachydesmoceras pachydiscoide* Matsumoto.
A—C: phragmocone of a huge form (macroconch ?), GK. H5794 from loc. T1052p, Abeshinai-Saku area (Coll. T. Muramoto, H. Okada, Y. Orita and T. Matsumoto); bar = 100 mm.

expansion generally high but may be moderate at some growth-stage; umbilicus fairly narrow, about 25 to 30 percent of the entire shell diameter in late growth-stages.

Whorl higher than broad, suboval in cross-section, broadest at some distance from the mid-flank toward the dorsum; flanks gently convex and convergent to the rounded venter; umbilical

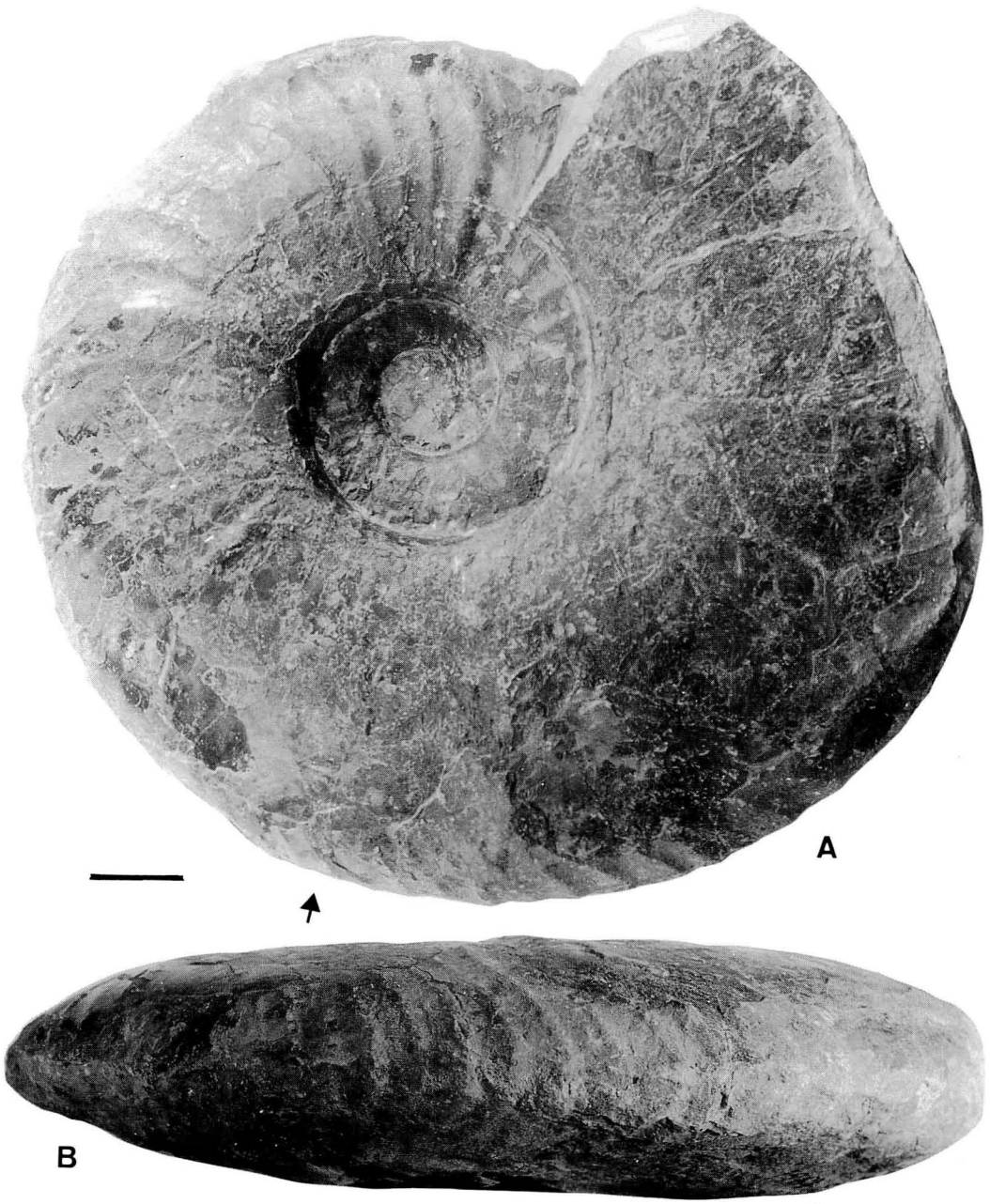


Figure 57. *Pachydesmoceras pachydiscoide* Matsumoto.
A—B: huge but rather compressed form, YKC. 590513 from a gully at Kashima, Oyubari area (Coll. Y. Kawashita; donated to Mikasa City Hall); bar = 50 mm.

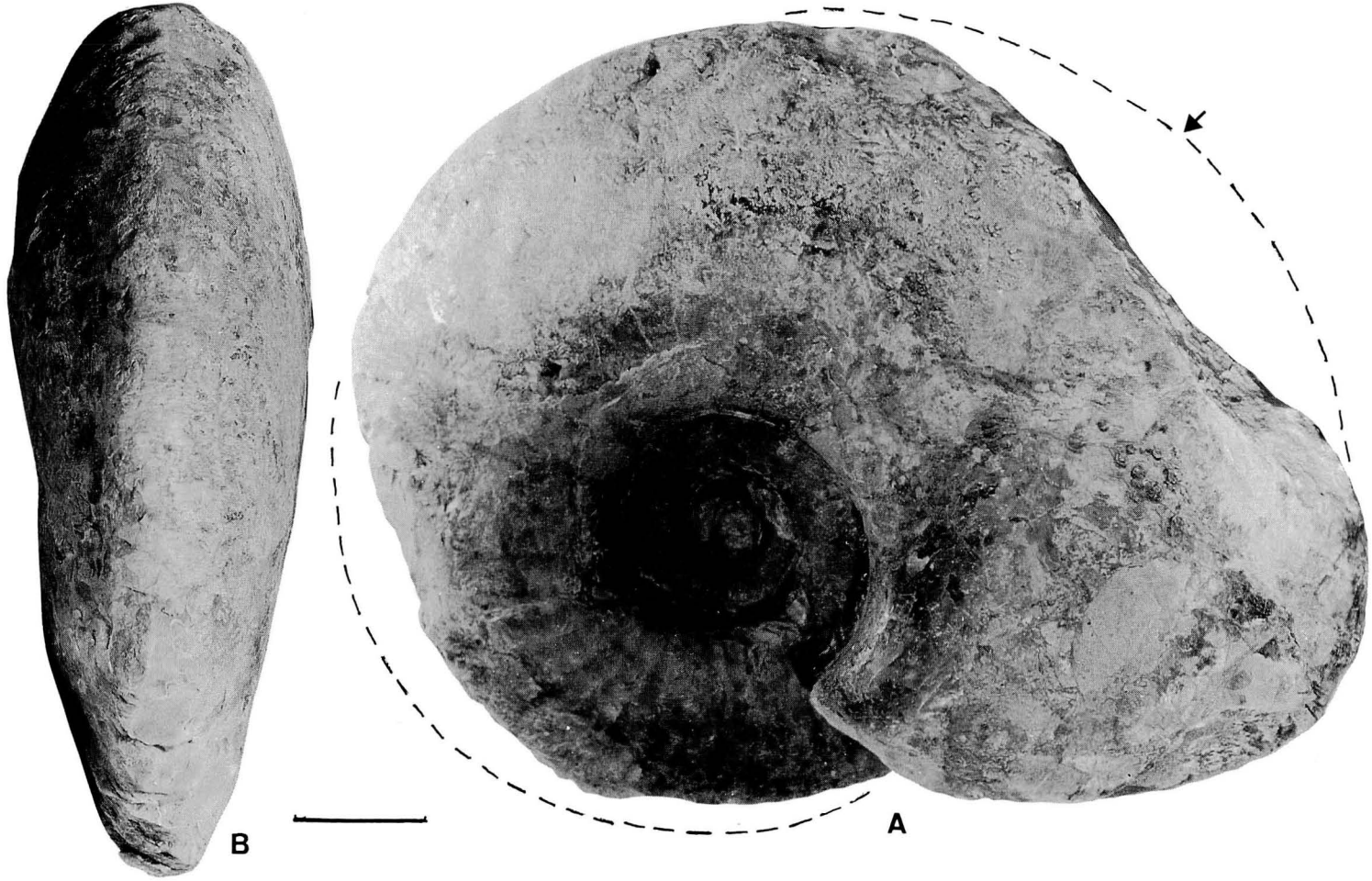


Figure 58. *Pachydesmoceras pachydiscoide* Matsumoto.
A—B: Huge form with broadening body-chamber, YKC. 570530 from a road cutting of the Kami-kinembets, Obirashibe Valley (Coll. Y. Kawashita, now kept at the Office, Mayor of Mikasa); bar = 100 mm.

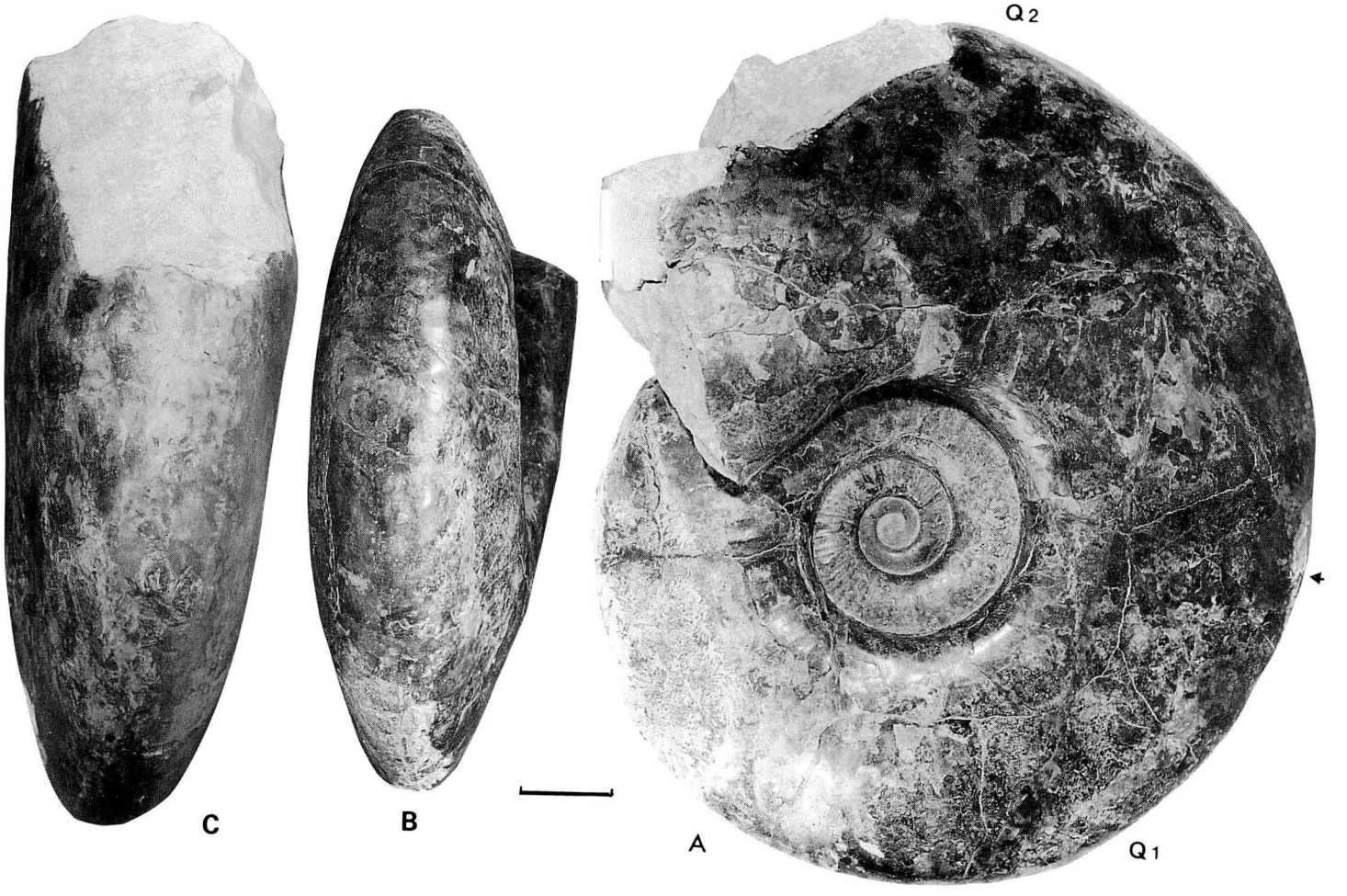


Figure 59. *Pachydesmoceras pachydiscoide* Matsumoto.
A—C: huge form of K. Morita Coll. from a road cutting of the Kaneobets, Oyubari area (on display at MCM in 1986). B, C: late part of the phragmocone passing to the body-chamber in two ventral views. Scale bar = 100 mm. See Fig. 60 for the whorl-sections.

shoulder generally subrounded but may be subangular or abruptly bent to the fairly high and nearly vertical wall in the late growth-stages.

Ribs develop as follows: Young shell at D = *c.* 30—40 mm ornamented with fien and short riblets or subcostae on the ventral part as those of *Puzosia*; the shell at a fairly early middle growth-stage (e.g. at D = 40—50 mm) begins to be ornamented with numerous, dense and narrow ribs of unequal length, gently arcuate or slightly sigmoidal on the flank with gradual forward curve on the outer part; longer ones arising at or near the umbilical margin; shorter ones themselves of unequal length, some being confined to the outer part of the whorl (i.e. outer flank and venter) and others extending to the middle part of the flank; normally longer and shorter ones alternated but rather irregularly and branching may occur rarely. The ribs become gradually more distinct, less dense and more arcuate (i.e. concave on the flank) with more outward projection as the shell grows.

The ribs of the adolescent stage thicker and coarser than those of the preceding stage, normally alternately long and short, concave on the main flank and projected on the outer part. The periodic flares with associated constrictions of moderate frequency, 4 to 6 per whorl, persisting to this stage. The number of ribs, including the major flares, 8 to 10 per 60°, i.e. about 12 to 15 per quarter whorl. Sooner or later on the outer whorl of the macroconch, i.e. at the last part of the phragmocone or at the early part of the body-chamber, ribs weaken and shorten, remaining only on the outer part with marked projection; flares indistinct and may be discernible as blunt radial elevations around the umbilicus but discontinuous to the outer ribs. This is followed by the almost smooth last part of the body-chamber in macroconchs.

The body-chamber of a microconch ornamented with long ribs at wide intervals, which are markedly projected on the outer part. No shorter rib intercalated.

Dimensions:—

Specimen	D	U	H	B	B/H	H/h	R/r	Inv.
Holotype	215	65 (.30)	98 (.46)	83 (.39)	0.85	1.75	—	0.63
(1) E	720	188 (.26)	325 (.45)	235 (.33)	0.72	1.58	1.44	0.55
(2) E	536	153 (.28)	230 (.43)	160	0.70	1.55	1.53	0.60
(3) LS	770	220 (.29)	312 (.41)	—	—	—		—
(4) LS + 90°	904	260 (.27)	380 (.45)	280 (.31)	0.74	1.50	1.43	0.63
(4) LS	760	216 (.28)	313 (.41)	227 (.30)	0.73	1.38	1.40	—
(5) LS + 70°	800	208 (.26)	360 (.45)	300 (.37)	0.83	1.67	—	0.58
(5) LS − 20°	660	168 (.25)	312 (.47)	230 (.35)	0.74	1.75	—	—
(6) LS	670							
(6) LS + 180°	967	263 (.27)	395 (.41)	348 (.36)	0.88	—	—	—
(7)	210	60 (.28)	90 (.43)	—	—	1.50	—	0.56

(1)—(6): specimens as numbered in p. 127; (7): measurements on the photograph of Collignon, 1961, pl. 12, fig. 1.

Observations:—The holotype shows the distant long ribs without intercalated shorter ones on its preserved last part, which is rather the ornament of an adolescent stage in this species. It is 220 mm in diameter at the preserved end, but it has a trace of the umbilical seam of still outer whorl, which must have been as large as 460 mm in a restored outline. Yet it is evidently smaller than most of other specimens.

The specimen (2) of the subsequent collections is 480 mm in diameter at the end of the phragmocone and would be at least 850 mm at the end of the body-chamber in a restored outline.

This is nearly two times as large as the restored holotype. The ribs shorten and weaken on the last part of its phragmocone and the preserved portion of its body-chamber is almost smooth. Therefore, we regard it as a macroconch and the holotype as a microconch of this species, although the apertural margin is not preserved.

It should be noted that several long ribs on the preserved last part of the holotype show a very gently sigmoid curvature on the inner flank. This may be a character of the microconch, suggesting a lappet which may appear at the peristome. On the outer part they are markedly projected forward as in other specimens.

There would be variation in size in both microconchs and macroconchs. Specimen (4) is 760 mm in diameter at the last septum and would be about 1300 mm on the assumption that the body-chamber would be as long as 210°. This may be a comparatively larger example among the macroconchs. Its outer whorl shows a peculiar change of form, at first at about 90° to 60° prior to the last septum the inner half of the flank is somewhat inflated, whereas the outer half is fairly compressed, with reduced ribbing on the outer part; then in the rest main part of the outer whorl the flanks are gently convex and the venter evenly rounded, resulting in a suboval section (see Fig. 60A—B); the surface is smooth at this stage.

Specimen (3) is about 770 mm at the last septem, being fairly similar in size to the preceding one (4). Specimen (5) is about 700 mm and (6) about 670 mm at the last septum. In these specimens ribs weaken in the last part of the phragmocone and the body-chamber is entirely smooth. A portion on the inner or inner middle part of the flank is bluntly but peculiarly inflated near the end of the phragmocone in specimen (5), about 180° from the last suture on the body-chamber of (3), with an accompanied shallow depressions or grooves on either side, and about 170° from the last suture in the body-chamber of (6) with a depression in front. Thus the existence of peculiar inflation on some part of the last whorl is a characteristic feature in the outer whorl of macroconchs of this species, although the mode of appearance varies from a specimen to another. Its meaning

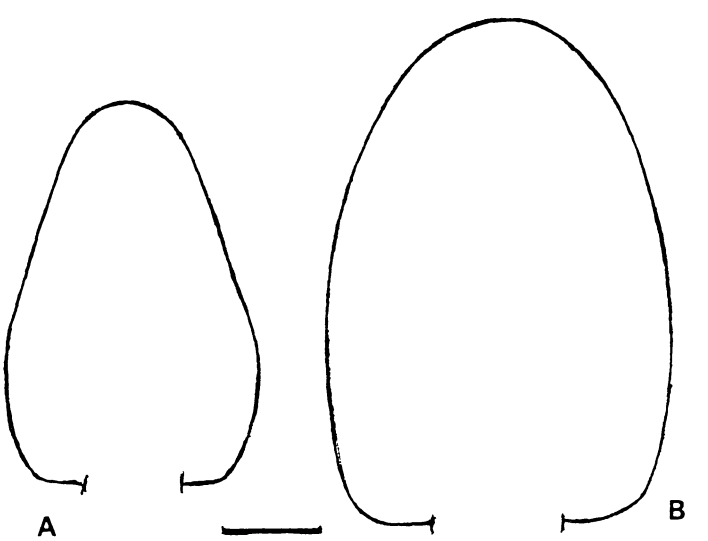


Figure 60. *Pachydesmoceras pachydiscoide* Matsumoto.
A—B: whorl-sections at Q1 and Q2 of Fig. 59A. Scale bar = 80 mm.

in life should be worked out.

Comparison and discussion:—This species is fairly similar to *P. kossmati* Matsumoto described above, but is distinguished in its less frequent flares on the phragmocones and its ribs of the adolescent stage are not so thick and strong as those of the late stage of the latter and that its ribs are reduced and the shell becomes smooth in the last growth-stage.

The outer whorl of *P. pachydiscoide* is generally more compressed than that of *P. kossmati,* but for a peculiar inflation at a certain part in macroconchs. Collignon (1961) described several specimens from the Zone of *Barroisiceras onilahyense* (Coniacian) of Madagascar under this species, which are quite similar in lateral view to those of our province but have broader outer whorls than ours. As there is variation in B/H among our specimens, the Madagascar form can be identified with *P. pachydiscoide.* Judging from the dimensions and illustration by Collignon (1961), the specimens from Madagascar seem to be microconchs. As examples of the microconchs from Sakhalin and Hokkaido are not sufficiently numerous, we should collect more specimens to lead a final conclusion on the above point. In fact the holotype (microconch) shows a comparatively larger ratio of B/H (0.85) among our material, which can be connected with a certain example (i.e. MNHN. 3766 with B/H = 0.86) from Madagascar. Incidentally the illustration by Collignon (1961, pl. 12, fig. 1) in lateral view does not match with the dimensions (ditto, p. 42) and no. 3768 in the explanation of plate may be a misprint of no. 3766.

A large specimen from South India reported by Sastry *et al.* (1969) is again atypical and may be a macroconch of *Mesopuzosia yubarensis.*

Occurrence:—The holotype was recorded roughly as the Miho Group of the Niabuchi Valley in South Sakhalin (Kawada, 1929) and its more precise stratigraphic position is not known. The paratypes were collected in 1937 by T. Matsumoto at loc. N123c, Zone Mh 3 (i.e. the Zone of *Inoceramus teshioensis*) (Upper Turonian) of the same area (see Matsumoto, 1942 for the location in detail). The specimens of the subsequent collections enumerated in this paper are from the Saku, Haboro, Obira and Oyubari areas of Hokkaido and stratigraphically range from the middle part of the Turonian (Zone of *I. hobetsensis*), through the Upper Turonian (Zone of *I. teshioensis*), to the Coniacian (Zone of *Inoceramus uwajimensis*).

A form with somewhat broad whorls described by Collignon (1961) and reviewed above occurs in the Lower Coniacian of Madagascar. An example from California (Matsumoto, 1959b) is typical and came from the upper part of the Turonian.

Pachydesmoceras mihoense (Matsumoto)

(By T. Matsumoto, Y. Kawashita, M. Yamashita and M. Kera)

Figures 61—65

1954b. *Jimboiceras mihoense* Matsumoto, p. 98, pl. 21, figs. 1—3.

Holotype:—UMUT. MM 9130 [= GT. I-2641] (Matsumoto, 1954b, pl. 21, fig. 1; this paper Fig. 61) from loc. N131m, Zone Mh 5 (= Zone of *Inoceramus mihoensis*) of the Miho Group, Naibuchi Valley, South Sakhalin (T. Matsumoto Coll.).

Paratypes:—7 specimens enumerated by Matsumoto (1954b, p. 98), of which 4 are kept in UMUT and 3 in GK. They are UMUT. MM 6652 [= GT. I-2642] (Ditto, pl. 21, figs. 2a, b) from

loc. N163a 3, top of Zone Mh 5; UMUT. MM 6653 [=GT. I-2650] (Ditto, pl. 21, fig. 3) from loc. N136, top of Zone Mh 5; UMUT. MM 6654 [=GT. I-2647] from loc. N133h, lowest part of Zone Mh 6α; UMUT. MM 6655 [=GT. I-2643] from loc. N136, Zone Mh 5; GK. H2455 from loc. N136a 4, top of Zone Mh 5; GK. H2457 and GK. H2460 from loc. N131b, Zone Mh 5 or Mh 6, all T. Matsumoto Coll. from the Miho Group, Naibuchi Valley, South Sakhalin.

Additional Material:—The following specimens in subsequent collections from Hokkaido in addition to the above specimens concern with this study: (1) No. 354 of M. Kera's Coll. (780604). (Fig. 62) from a boulder of the Ohmaki-zawa, at about 2 km linearly eastward from the confluence with the River Yubari, Oyubari area (Zone of *Inoceramus mihoensis* according to the geological map by Haraguchi *in* Matsumoto and Haraguchi, 1978, fig. 1); (2) YKC. 600609—2 (Fig. 63)

Figure 61. *Pachydesmoceras mihoense* (Matsumoto).
Holotype, UMUT. MM 9130 from loc. N131m, Zone Mh5 (*Inoceramus mihoensis* Zone) of the Naibuchi area, South Sakhalin (Coll. T. Matsumoto), × 0.95; bar = 10 mm.

obtained by Y. Kawashita, together with *Inoceramus mihoensis,* from a small branch stream of the River Obirashibe, east of Kawakami, Obira area; (3) YKC. 560727, half damaged specimen, obtained by Y. Kawashita at the entrance of the Koya-no-sawa, a branch in the upper reaches of the Ikushumbets; (4) No. 390 of M. Kera's Coll. (820530) (Fig. 65) from a boulder of the Oku-hidarimata-zawa, in the uppermost reaches of the River Ikushumbets, along which mudstones of Coniacian age (Zone of *Inoceramus uwajimensis* and Zone of *I. mihoensis*) are well exposed; (5) GK. H8126 (Fig. 64), a pebble of the Yubarigoe-no-sawa, another branch in the uppermost reaches of the River Ikushumbets, along which mudstones of the Upper Coniacian Zone of *I. mihoensis,* with *Gauthiericeras* aff. *margae* (Schlüter), and lower part of the Santonian Zone of *Inoceramus amakusensis* are exposed (Y. Kawashita and T. Matsumoto Coll.); (6) GK. H8127 obtained by S. Toshimitsu from his loc. RH2430h 1, the Machiyoi-zawa in the upper reaches of the River Haboro, lower part of the Middle Haborogawa Formation (Upper Coniacian-Lower Santonian) (See Toshimitsu, 1985 for the location and stratigraphic sequence). (7) T. Sawamura's

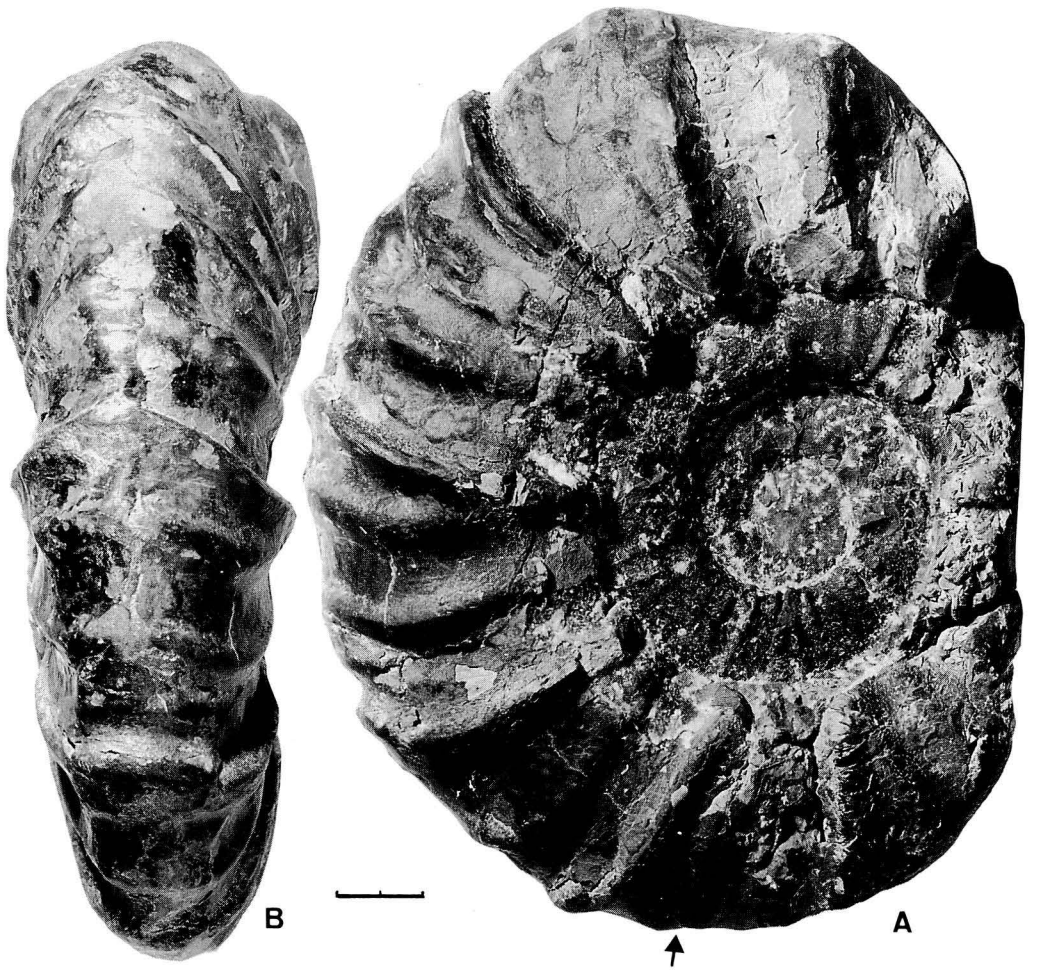


Figure 62. *Pachydesmoceras mihoense* (Matsumoto).
A—B: example of adult shell, M. Kera Coll. no. 354 from the Ohmaki-zawa, Oyubari area; scale bar = 20 mm.

Coll. with M. Yamashita, from the Haboro area, on display at MCM.

Diagnosis:—Macroconch fairly large; microconch somewhat (but not much) smaller than macroconch. Umbilicus shallow and fairly wide (38 to 43% of D), with moderate to rather small involution of whorl, that is less than 1/2 to 1/3 in height of the inner whorl overlapped by the outer one. Whorl somewhat or a little higher than broad, or even slightly broader than high in some cases, suboval or subcircular in cross-section, with moderately rounded ventral part, gently convex flanks, normally broadest at some distance from the mid-flank to the dorsum, but sometimes nearly parallel sided on the inner whorl.

Constrictions frequent and well marked (i.e. fairly deep and broad) on the phragmocone, somewhat prorsiradiate with gently sigmoidal or simply concave curvature or nearly straightly inclined forward in lateral view, crossing the venter with gently convex curve or sometimes with obtuse chevrons.

Ribs appear fairly early in young stage, becoming moderately coarse in the middle growth-stage, and very coarse and distant in the last part (about a half whorl) of the phragmocone. Those behind the constrictions are more elevated than others and can be called flares which are thick and strong in the last part of phragmocone. Several ribs on each interspace of the constrictions of unequal length; some as long as the flares, arising from the umbilical margin; some others of medium length, reaching the inner flank or branched from the long one at a point not far from the umbilical margin; still others short, disposed on the outer part, normally intercalated between the longer ones but sometimes branched from or accompany behind the longer ones.

The adult body-chamber free from constrictions and ornamented with strong major ribs at wide intervals, which are rectiradiate or slightly prorsiradiate on the main part of flank and may curve forward to various degrees on the outer part. Some of the major ribs may be acompanied behind by shorter, minor ones and occasionally an intercalary rib of moderate length may occur at the middle of the interspace between the major ones.

Suture of *Puzosia* pattern.

Dimensions:—

Specimen	D	U	H or H' (ic)	B	B/H	H/h	H'/h	Inv.
Holotype (E)	145.0	59.0 (.41)	48.4 (.33)	39.0 (.27)	0.81	1.29	—	0.34
Para. MM 6653 (E)	82.0	33.3 (.41)	29.7 (.36)	24.2 (.30)	0.81	1.56	—	—
Add. (1) LS + 140°	193.0	78.0 (.40)	*c.* 70.0 (.36)	*c.* 63.0 (.33)	0.90	1.55	—	0.48
Add. (1) LS + 20°	158.0	65.0 (.41)	55.0 (.35)	44.0 (.28)	0.80	1.45	—	0.44
Add. (2) LS − 10°	140.0	57.0 (.41)	49.5 (.35)	48.6 (.35)	0.98	1.48	—	—
Add. (3) LS + 30°	*c.* 162.0	67.0 (.41)	*c.* 57.0 (.35)	*c.* 53.0 (.33)	0.93	—	—	0.47
Add. (4) LS + 140°	182.5	78.5 (.43)	H' 59.5 (.33)	*c.* 58.0 (.32)	0.98	—	1.34	0.41
Add. (5) LS + 180°	65.0	27.6 (.42)	21.3 (.33)	21.0 (.32)	0.99	1.31	—	—
Add. (5) LS	48.8	18.6 (.38)	16.3 (.33)	16.6 (.34)	1.02	—	—	—
Add. (6) LS	72.5	29.4 (.41)	25.6 (.35)	21.4 (.30)	0.84	1.31	—	—

Observations:—The holotype and paratypes from South Sakhalin were more or less secondarily deformed, but the specimens in the subsequent collections from Hokkaido are sufficiently better preserved for us to supplement the previous deficiency as well as to confirm the characteristics.

The characters of small or immature shells are shown by UMUT. MM 6653 (Matsumoto, 1954b, pl. 21, fig. 3), GK. H8126 (this paper Fig. 64), GK. H8127 and the inner whorls of certain

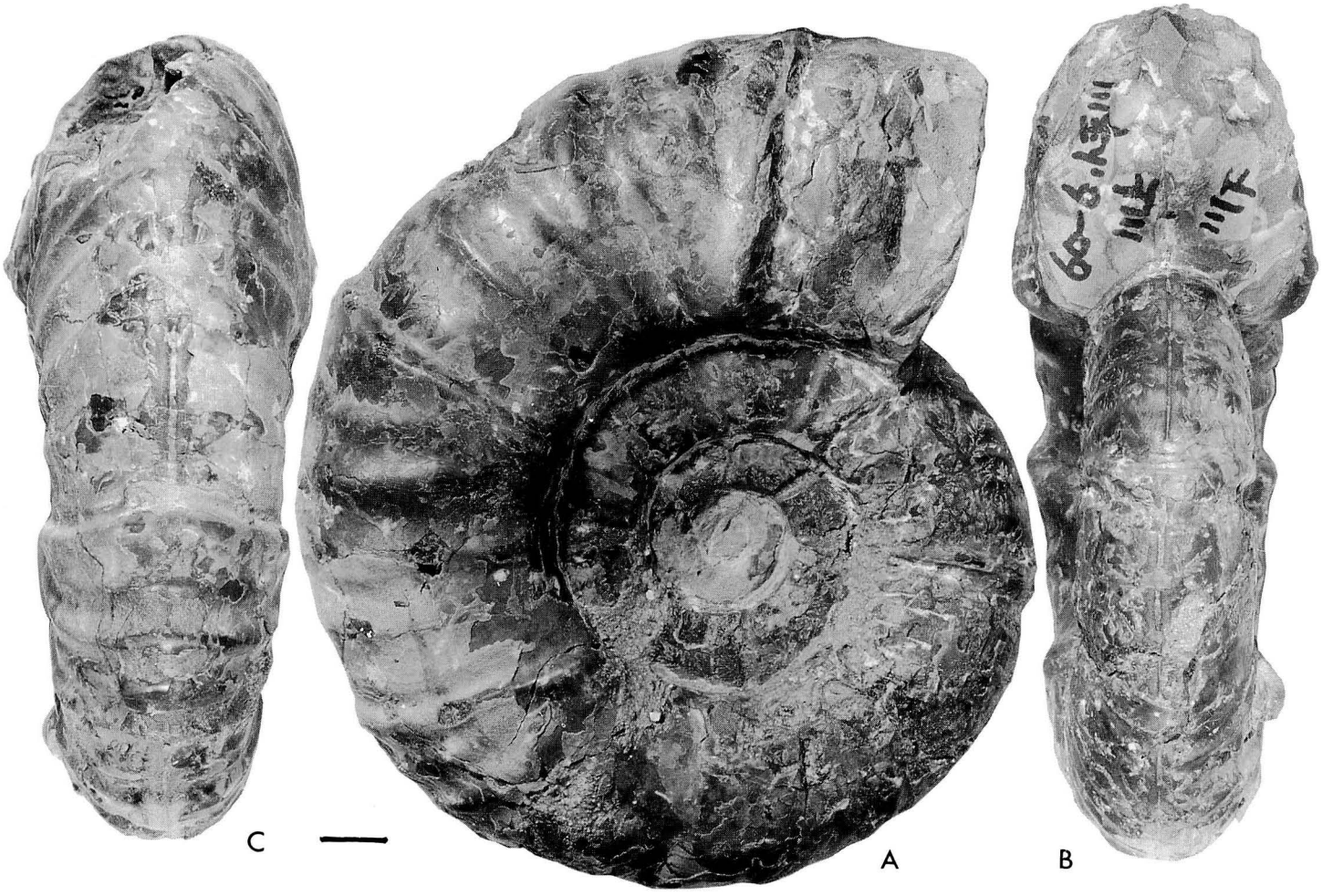


Figure 63. *Pachydesmoceras mihoense* (Matsumoto).
A—C: example of phragmocone, YKC. 600609—2 from Kawakami, Obirashishibe Valley (badly crushed body-chamber excluded) (Coll. Y. Kawashita); bar = 10 mm.

larger specimens (e.g. YKC. 600609-2, Fig. 63). The first three smaller specimens enumerated above have the last suture at D = 60 mm, 50 mm and 75 mm respectively and the body-chamber is preserved partly. They are quite similar in shell-form, constrictions and ribs to the earlier or inner whorls of a middle-aged specimen shown in Fig. 63, whose adult body-chamber was badly squashed and taken away. Therefore, they are regarded as fossils of young shells. In the immature stage fine but distinct ribs of considerable length begin to develop already at diameter of about 20 mm, constrictions are frequent, 7 per whorl, and prorsiradiate on the main part of flank; at first narrow but fairly deep and soon become broad and deep. The ribs become also fairly coarse at this stage, some of which are somewhat sigmoidal and others simply concave. Branching (normally bifurcation) of the rib near the umbilical margin or on the inner flank occurs here and there.

The dimorphism in this species is inferred from the size difference. The diameter of the holotype is about 120 mm at the last suture and, judging from the trace of the umbilical seam, the body-chamber is at least 210° in spiral length. Assuming that U/D be kept 0.41, the entire shell diameter would have been about 170 mm.

On the other hand the diameter at the last suture is about 140 to 150 mm in the four larger specimens (1—4) and they must have been about 200 mm to 220 mm in diameter, if the body-chamber were complete.

We interpret that the holotype is a microconch and the above mentioned four specimens are macroconchs. UMUT. MM 6652 (Matsumoto, 1954b, pl. 21, figs. 2a, 2b) is a secondarily deformed, incomplete paratype but interpreted as a macroconch, because its body-chamber corresponds in size roughly to that of the above mentioned larger specimens.

To confirm the inferred dimorphism, we should search for the specimens which preserve

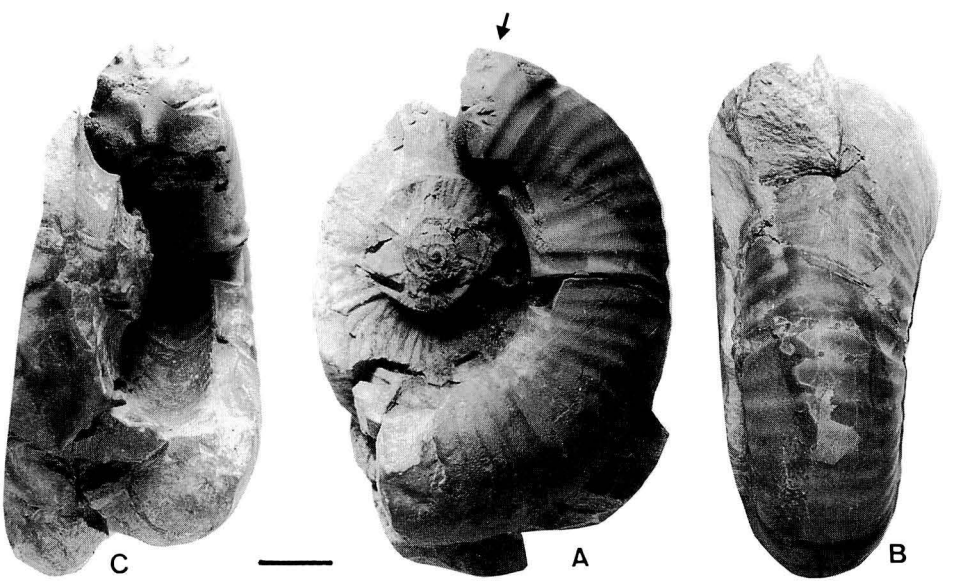


Figure 64. *Pachydesmoceras mihoense* (Matsumoto).
A—C: possibly microconch or immature example, GK. H8126 (internal mould of outer whorl and external mould of inner whorls) from loc. Ik 8387p. upper reaches of the Ikushumbets River (Coll. Y. Kawashita and T. Matsumoto); bar = 10 mm.

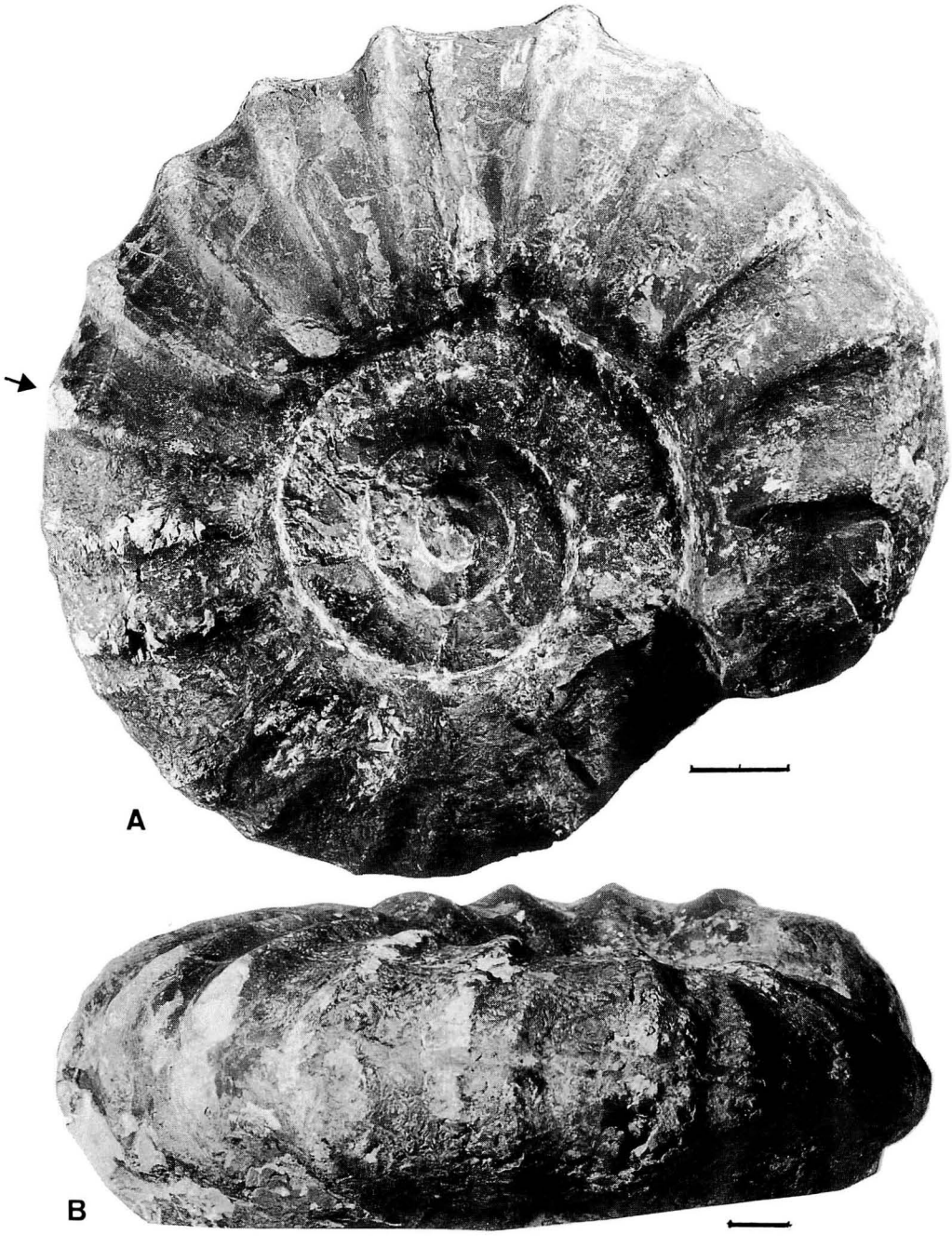


Figure 65. *Pachydesmoceras mihoense* (Matsumoto).
A—B: example of adult shell (macroconch ?), M. Kera Coll. no. 390 from the Oku-hidarimata-zawa, upper reaches of the Ikushumbets. Scale bar for A: 20 mm (× 0.7) and for B: 10 mm (× 0.8).

the apertural margin.

There is some extent of variation in the mode of ribbing. The holotype has rigidly rectiradiate and much distant major ribs on the body-chamber. The paratype mentioned above has also nearly rectiradiate major ribs and a somewhat narrower rib on the wide interspace of the major ribs. Among the material from Hokkaido, Kera's no. 390 has rather rectiradiate or gently curved major ribs with scarcely intercalated minor ribs on the body-chamber, whereas on the body-chamber of Kera's no. 354 the major ribs are somewhat prorsiradiate and curved considerably forward at about the ventrolateral shoulder and some of them show obtuse chevrons on crossing the venter; also major ribs are accompanied behind by the shorter ribs. Anyhow, the above variation in ribbing is not dimorphic but seems to be individual and sometimes occurs at different substages within the outer whorl of one and the same specimen. Also the major ribs of the outer whorl may sometimes be slightly thicken, if not tuberculate, at the umbilical shoulder.

Comparison and discussion:—The characters of the young shell of this species as described in the preceding pages are fairly similar, if not identical, with those of the young shell of *Jimboiceras planulatiforme,* especially in the well-marked, fairly frequent, somewhat prorsiradiate constrictions and occasional branching or bifurcation of ribs on the inner flank.

In the adult stage the two species are also similar in the approximate size of the shell, proportion of size between micro- and macroconchs, generally rounded section of the outer whorl and the branching of ribs appearing also on the outer whorl. In the ribbing of the late growth-stage, however, the two species are considerably different. In *J. planulatiforme* the periodic flared ribs strengthen but the ribs on the interspaces are as numerous and crowded as those in the middle-aged shell, although they may be somewhat coarsen. In *J. mihoense* strong major ribs are disposed at wide intervals without or with only a few shorter ribs on each interspace of the major ribs. This mode of ribbing is similar to that on the body-chamber of *Pachydesmoceras rarecostatum* Collignon (1961, pl. 9, figs. 1, 1a), which is also rounded in cross-section. The two species look so similar that we are inclined to transfer *J. mihoense* to *Pachydesmoceras.* In fact, Matsumoto (1954b, p. 99) once mentioned that the phragmocone of *Jimboiceras mihoense* is similar in aspects to *Kossmaticeras* of *theobaldianum* group, whereas Collignon (1961, p. 40) said that *P. rarecostatum* looks apparently similar to *K. sparsicostatum* (Kossmat).

As one of us (T. M.) remarked generally on the genus *Pachydesmoceras, P. rarecostatum* and *P. radaodyi* Collignon (1964, p. 58, pl. 333, fig. 1498), from the Cenomanian of Madagascar, are atypical members of *Pachydesmoceras.* These species have extraordinary strong ribs on the adult body-chamber as those of *Eupachydiscus* or even some *Calycoceras.* Therefore, it could be an idea to introduce a new genus for *P. mihoense* and these two species, but we should refrain from such a hasty procedure, for the available evidence is yet insufficient.

In *P. rarecostatum* the strong and distant ribs of the adult stage seem to appear rather abruptly, but in *P. mihoense* there is an intermediate substage in the last half whorl of the phragmocone (for details see the diagnosis). The change of characters with growth is, therefore, fairly similar to that in the typical members of *Pachydesmoceras,* although the alternating long and short ribs may not be shown so regularly as in the latter.

Occurrence:—So far as the available material is concerned, this species occurs characteristically in the limited part from the upper part of the Coniacian to the lower part of the Santonian in Hokkaido and Sakhalin.

Genus *Epipuzosia* Matsumoto, nov.

Epipuzosia maya sp. nov.

(By T. Matsumoto and Y. Kawashita)

Figures 66—68

Holotype:—YKC. 570915 (Fig. 66) obtained by Y. Kawashita from the mudstone of Member Mj of Tanaka (1963; *in* Igi *et al.*, 1958) at loc. R8024 of T. M. (see Fig. 87) in the upper reaches of the River Obirashibe, Obira area.

Paratypes:—GK. H8100 (Fig. 67) and GK. H8101 (Fig. 68) from loc. R2101 (R2101b and R2101m respectively), cliff on the right side of the stream at the outlet of the Kanajiri-zawa, tributary to the River Obirashibe (T. M. Coll.). Unillustrated specimen from loc. R8004, 650 m north of R8024 (Y. K. & T. M. Coll.).

Diagnosis:—Shell very large, about 610 mm in diameter of the holotype, with moderate rate of whorl expansion, moderate involution and umbilicus of moderate width.

Outer whorl somewhat higher than broad, and suboval in cross-section, with moderately rounded venter, gently convex flanks, maximum breadth somewhat dorsad from the mid-flank, subrounded to subangular umbilical shoulder and steep to nearly vertical umbilical wall.

Generally in the late growth-stage the whorl broadens very gradually with age, with slow increase in the ratio of B/H and also in the height of umbilical wall. In the main part of the body-chamber, at some distance from the end of the phragmocone, the umbilical shoulder may stand out in a peculiar way to form overhanging umbilical wall and eccentric deviation of the umbilical seam from the normal spiral outline.

The outer whorl, which consists of the body-chamber and the last part of the phragmocone, ornamented with a row of button-like low knobs at moderate intervals at the sloping ventrolateral shoulders and very weak, rectiradiate major ribs on the main part of the flank. The ribs do not always reach the umbilical shoulder and are sometimes interrupted from the knobs by lowered or smoothed portions inbetween. These ornaments are so faint that they may be scarcely observed and the surface may look almost smooth at least partly. The next inner whorl looks also nearly smooth, but for weak periodic flares.

Pattern of suture similar to that of *Puzosia,* being finely and deeply incised in the late growth-stage.

Etymology:—Maya is the mother of the Buddha.

Dimensions:—

Specimen	D	U	H	B	B/H	H/h
Holotype (E)	610.0 (1)	187.0 (.31)	250.0 (.41)	194 (.32)	0.78	1.44
Holotype (LS)	462.0 (1)	142.0 (.31)	188.0 (.41)	135 (.29)	0.72	1.42
GK. H8100 (E)	—	—	205.0	158.0	0.77	—
GK. H8100 (E–120°)	—	—	151.0	112.0	0.74	—
GK. H8101 (E)	—	—	220.0	166.0	0.74	—

Observation:—The body-chamber of the holotype is somewhat distorted and the above measurements on the actual specimen without restoration would give approximate dimensions.

The peculiarly standing out of the body chamber at about the umbilical shoulder with acompanied deviation of the umbilical margin from the normal spiral outline is an original character of this species, although the feature may have been somewhat modified by the secondary

Figure 66. *Epipuzosia maya* sp. nov.
A—B: holoype, YKC. 560915 from the upper reaches of the River Obirashibe (Coll. Y. Kawashita). Two side views in the light of different orientation; bar = 50 mm.

distortion. We have seen the same feature in other specimens from locs. R8004 and R8015.

The specimens at our disposal are not sufficient to tell the extent of variation and also the change of characters with growth. It is noted, however, that the holotype and GK. H8100 show nearly the same dimension (about 190 mm) of whorl-height at the end of the phragmocone and that GK. H8101, which came from the same bed as GK. H8100, shows somewhat larger whorl-height than the above dimension, although it is still septate.

The dimorphic pair has not yet been confirmed for this species. The somewhat broadening body-chamber and its peculiar buldge at the umbilical shoulder, as well as the huge size, suggest us that the described specimens may represent macroconchs. A microconch example of this species has yet to be confirmed.

Incidentally, the internal suture is exposed on the inner whorl of GK. H8100. It is essentially similar to that of previous illustration on a species of *Puzosia* (e.g., Kossmat, 1898, pl. 16, fig. 4).

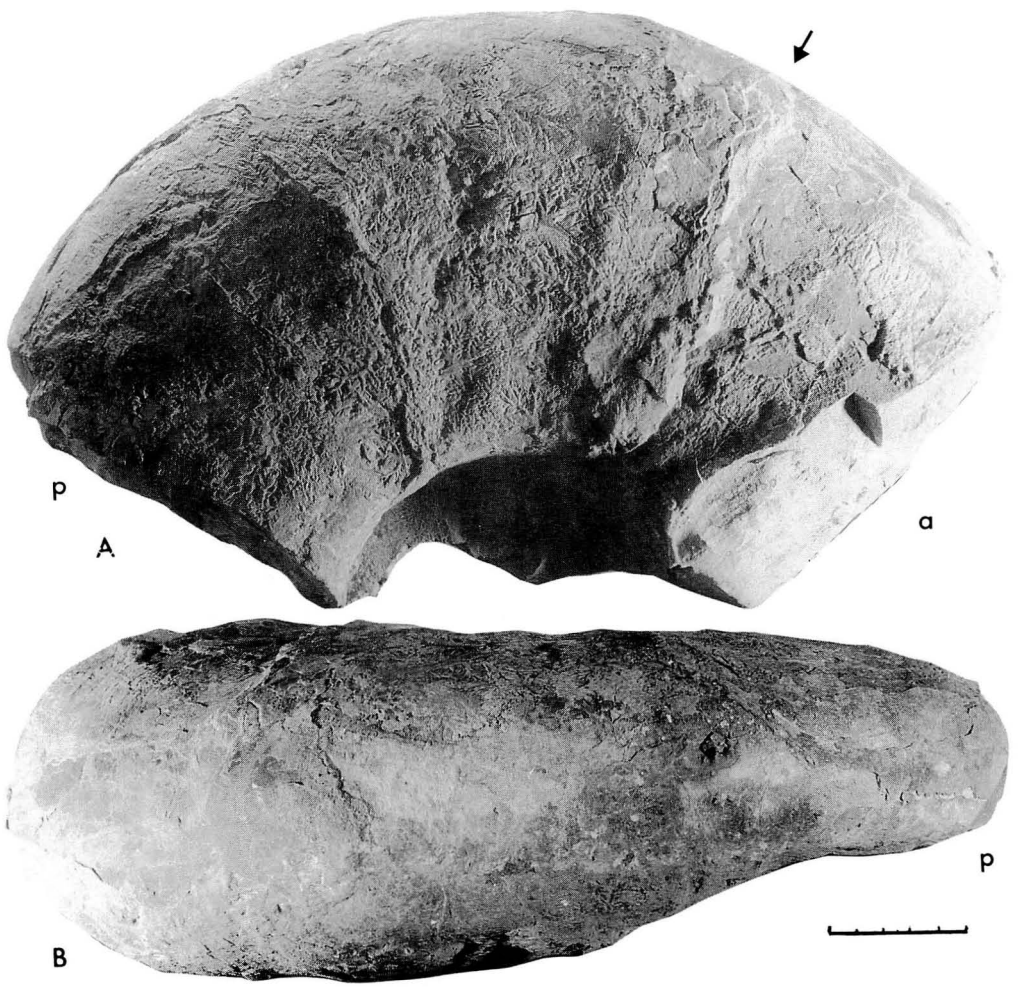


Figure 67. *Epipuzosia maya* sp. nov.
A—B: paratype, GK. H8100 from loc. R2101b of the Obirashibe Valley (Coll. T. Matsumoto). Preserved posterior part secondarily compressed. a: anterior; p: posterior. Scale bar = 50 mm.

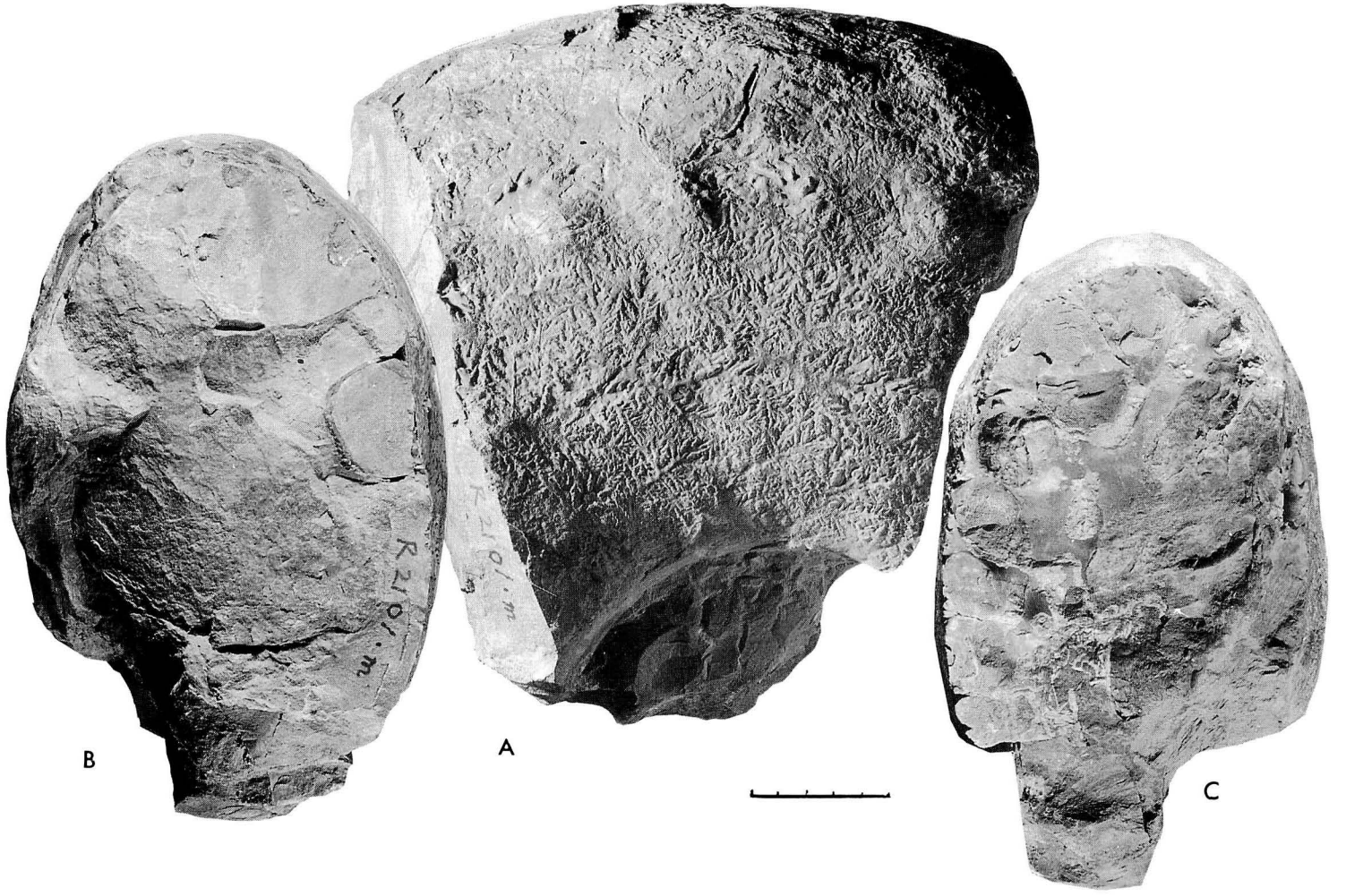


Figure 68. *Epipuzosia maya* sp. nov.
A—C: paratype, GK. H8101 from loc. R2101m of the Obirashibe Valley (Coll. T. Matsumoto). Fragmentary piece of septate whorl (A), natural cross-section at its anterior (B) and posterior (C) ends; scale bar = 50 mm.

Comparison and discussion:—This species is almost contemporary with *Pachydesmoceras kossmati* but the distinction is clear between them. The latter has a marrower umbilicus and more involute, inflated and rounded outer whorl on which strong, alternating long and short ribs develop; the ribs are concave on the flank and projected on crossing the venter. In the former the major ribs on the outer whorl are rather rectiradiate, without notable curvature, extremely weak and discernible only on the middle part of the flank, leaving the venter entirely smooth; the ventrolateral row of the button like knobs is characteristic of this species, although they may be very weak on some part.

Pachydesmoceras denisonianum of the Albian and Cenomanian ages may be similar to this species in shell-form, but has more distinct ribs on the next inner whorl and much stronger and coarser ribs on the outer whorl, which are curved forward (hence concave) on the flank.

Pachydesmoceras pachydiscoide of the late Turonian to early Coniacian age has comparatively finer ribs and less inflated whorls among other species of *Pachydesmoceras*; its whorl-section is suboval as that of *E. maya* but its whorl expansion is higher than that of the latter, and the ribs are projected markedly on the outer part of the whorl. In the large outer whorl of the macroconch of *P. pachydiscoide,* the ribs weaken and disappear; according the surface is nearly smooth but devoid of such ventrolateral knobs as those of *E. maya.*

There are such strongly ribbed and deeply constricted species in *Pachydesmoceras* as *P. rarecostatum,* which are much different from *E. maya.*

To sum up, this species is sufficiently distinct from any species of *Pachydesmoceras* to require a new genus for itself.

The specimen (J28161, Naturhistorisches Museum, Basel) from the Lower Cenomanian of the Swiss Jura, which was described by Renz (1976, p. 759, pl. 1, figs. a—b) under *Pachydesmoceras* aff. *denisonianum,* resembles the holotype of *E. maya* in its very large size, general aspects of shell-form, ventrolateral knobs and weak major ribs on the main flank of the body-chamber. Its dimensions given by Renz (1976, p. 760) show somewhat narrower umbilicus (U/D = 0.26) and broader body-chamber (B/H = 0.88) than the holotype and paratypes of *E. maya.* It shows weak ribs and periodic flares on its next inner whorl, whereas the inner whorl of *E. maya* looks nearly smooth, but for weak, infrequent flares, although *E. maya* may have short riblets on the unexposed outer part of the inner whorl. Anyhow, *P. denisonianum,* represented by the lectotype (see Matsumoto, 1987 and also this paper) has coarser and stronger ribs on the next inner whorl and broader, stronger, and arcuate (concave) major ribs on the outer part. That Swiss specimens thus differs from *P. denisonianum* and it is better to call it *Epipuzosia* aff. *maya.* We suggest that it represents presumably another species which is allied to but distinct from *E. maya,* but we hesitate to establish a new species for it in this paper.

Occurrence:—The type locality is stratigraphically allocated at about the top of Member Mj (of Tanaka, 1963) exposed in the very upper main course of the River Obirashibe. Loc. R2101 of the illustrated paratypes falls in the basal part of Member Mk, according to the official geological map of Tappu (Tsushima *et al.*, 1958, which was followed by Tanabe *et al.*, 1977, text-fig. 6), in the upper reaches of the River Obirashibe; but it could be allocated at about the top of Member Mj. Some other examples came from the localities near the type locality on the extension of the same stratigraphic level. Judging from our experience in field work the species cannot be said rare, although it is not easy to obtain well preserved specimens.

The strata at about the boundary of Mj-Mk are not so prolific as the Zone of *Inoceramus*

aff. *hobetsensis* (main part of Mk) above. Therefore the age of this species is hardly decided with precision, but it is somewhere within the range from upper part of the Lower Turonian to lower part of the Middle Turonian.

Genus *Hyperpuzosia* Matsumoto, nov.

Hyperpuzosia tamon sp. nov.

(By T. Matsumoto, Y. Kawashita and T. Takahashi)

Figures 69—77

Material:—Holotype YKC. 480628-1 (Pombets 23) (Figs. 69, 70A), from a southern small gully at the point southwest of the confluence of the Migi-mata-zawa with the Oku-futamata-zawa in the upper reaches of the Pombets, a tributary to the River Ikushumbets (Figs. 88).

Paratypes:—YKC. 480628-2 (Pom. 24) [Pom. = Pombets] (Figs. 70B—C, 71), YKC. 501005 (Pom. 2) (Fig. 72), NSM. MM 9597 (= Pom. 7) (Fig. 73), YKC. 490927 (Pom. 10) (Fig. 74), YKC. 560820 (Pom. 5) (Fig. 77), from the Oku-futamata-zawa in the upper reaches of the Pombets, GK. H8103 (Figs. 75) from loc. Ik 2918p, *ditto*, all collected by Y. Kawashita; GK. H8104 (Fig. 76), obtained by a student of Mikasa High School from a boulder of the River Pombets. Several other specimens obtained in 1956 by T. Takahashi and Matsumoto from loc. Ik 2060 (Onko-no-sawa) and Ik 2075 (Magari-zawa, subparallel to the Onko-no-sawa about 500 m northeast of the Onko) in the collection of GK; TTC. unnumbered from the Gakko-no-sawa, a gully on the northwestern side of the Pombets valley; TTC. 370722 and other fragmentary specimens from locs. Ik 2932 and Ik 2940, 163-Rinpan-no-sawa, southern tributary to the Pombets.

Etymology:—Tamon-ten, an armoured divinity who is believed to guard the Buddhist people against demons in the north.

Diagnosis:—Adult shell very large, about 420 to 490 mm in diameter. Inner whorl flat-sided and somewhat higher than broad or nearly as high as broad. The outer whorl, of which about 210° to 240° is occupied by the body-chamber, low in the rate of expansion in whorl-height, less involute and accordingly, moderately to fairly widely umbilicate.

From the last part of the phragmocone onward, the whorl broadens to have subquadrate to subtrapezoid section, with rather divergent flanks; the strongly ribbed body-chamber much modified in various shape in costal section in accordance with the change in ribbing, showing generally much broadened venter. A faint longitudinal elevation normally discernible along the median line of the venter. Umbilical wall steeply inclined and sometimes nearly vertical. Intercostal section of body-chamber subrounded and sometimes like a head of Cupid.

Inner whorl nearly smooth, only with weak subcostae on the outer part (*i.e.* outer flank and venter) and indistinct constrictions and associated weak "flares" which are nearly rectiradiate or curved gently forward on the flank. In the last part of the phragmocone the flares become more frequent and develop to major ribs which are narrow at first and thicken and much strengthen on the body-chamber with horn-like culmination at the ventrolateral shoulder, whereas minor outer subcostae disappear. Altogether 11 to 13 ribs on the last whorl, of which the last third and/or fourth the strongest and provided with the most prominent horn. The ribs of the body-chamber gently concave forward or nearly rectiradiate on the flank. They extend beyond the ventrolateral horn with somewhat forward orientation and much broaden and lower on the venter. The interspaces between the strong ribs wide and concave.

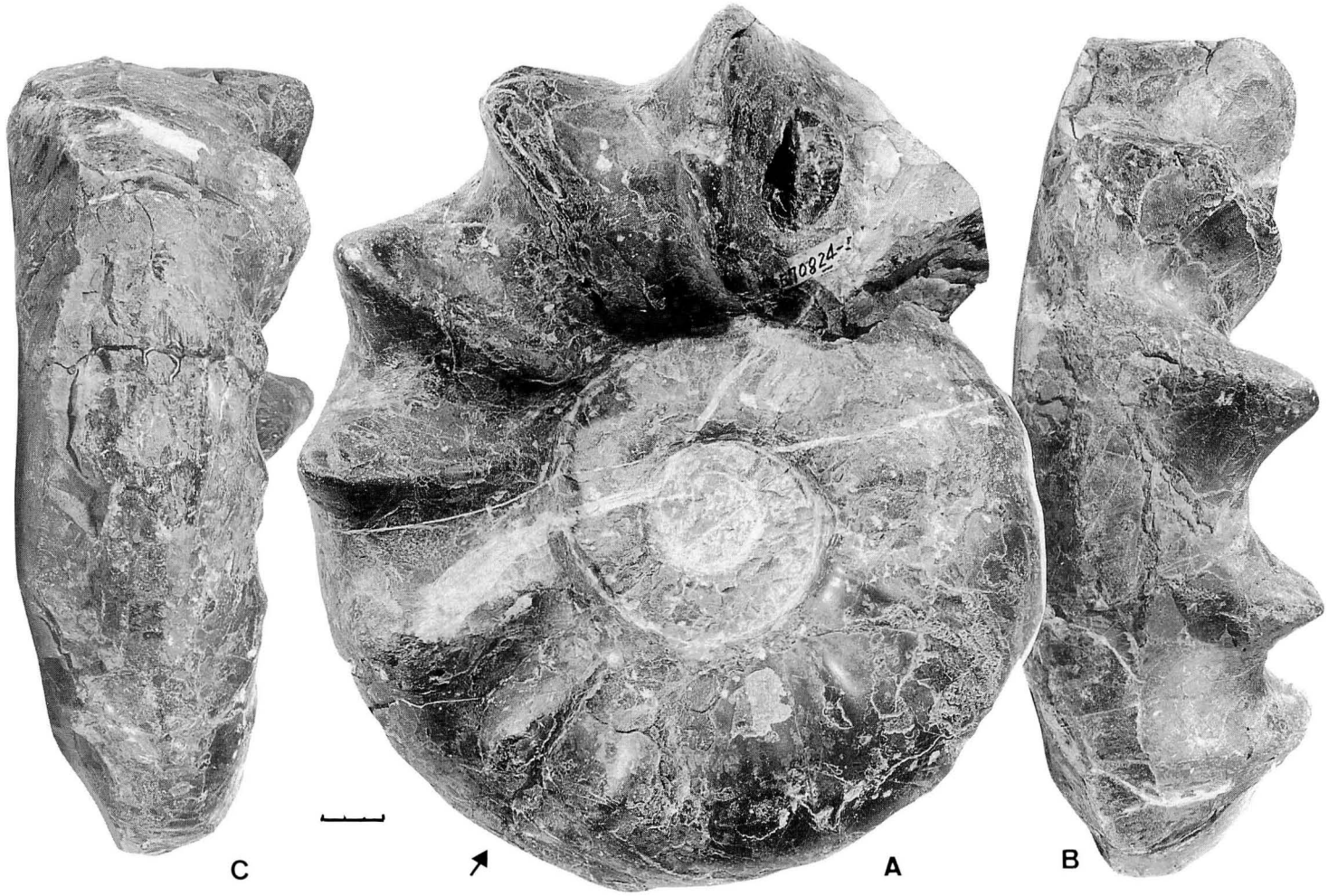


Figure 69. *Hyperpuzosia tamon* sp. nov.
A—C: holotype, YKC. 480628-1 (Pombets 23) from the upper reaches of the Pombets, tributary to the Ikushumbets River (Coll. Y. Kawashita); scale bar = 30 mm. Lateral (A) and ventral views of the entire body-chamber (B) and from the last part of phragmocone to the beginning of body-chamber (C).

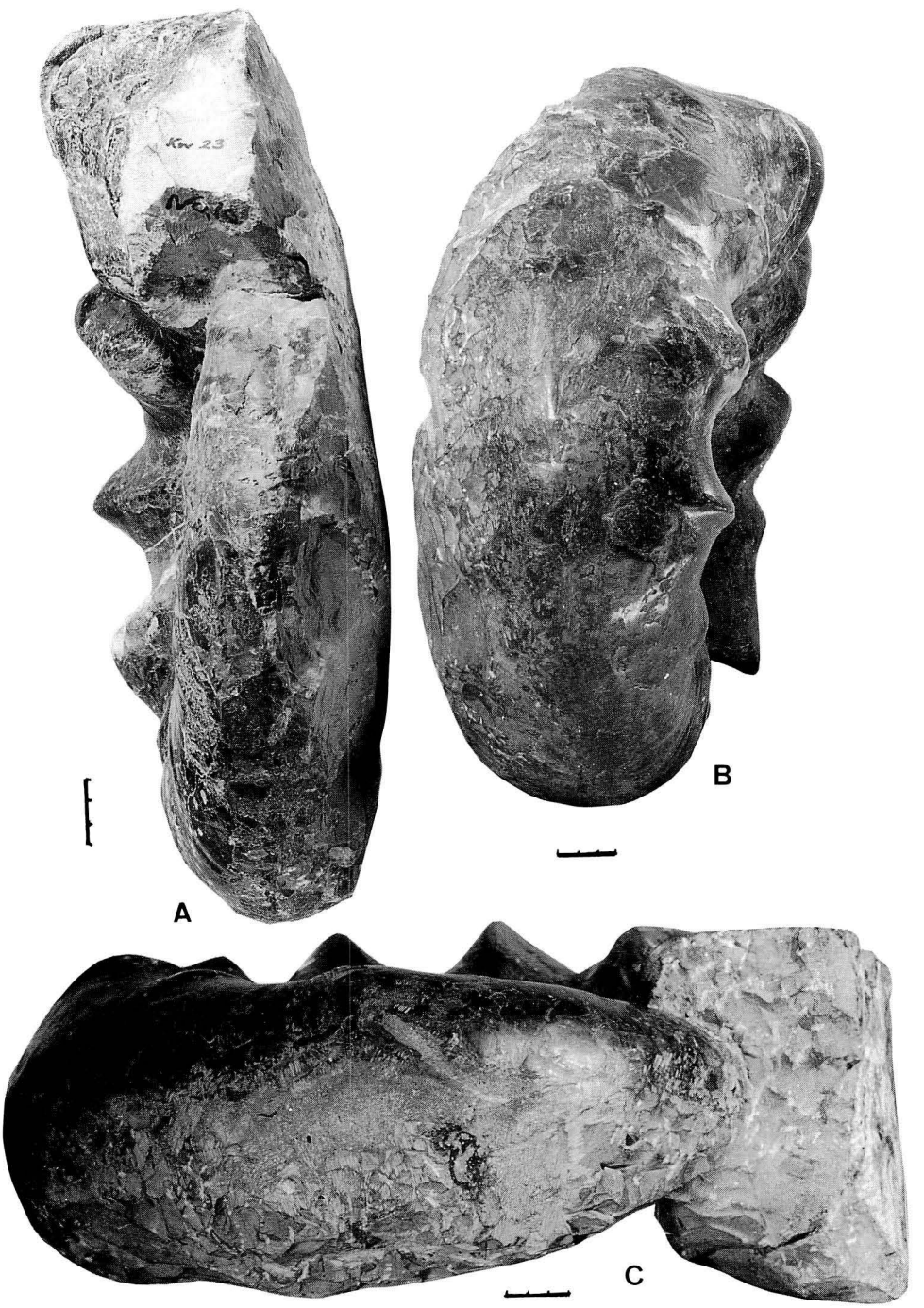


Figure 70. *Hyperpuzosia tamon* sp. nov.
A: holotype, YKC. 480628-1 (Pombets 23), frontal view; scale bar = 30 mm. (See Fig. 69A—C for other views); B—C: paratype, YKC. 480628-2 (Pombets 24), ventral view of early half of body-chamber (B) and frontal view showing the venter of the last part of phragmocone (C), scale bar = 30 mm. C slightly enlarged than B. (See Fig. 71 for other view of this specimen.)

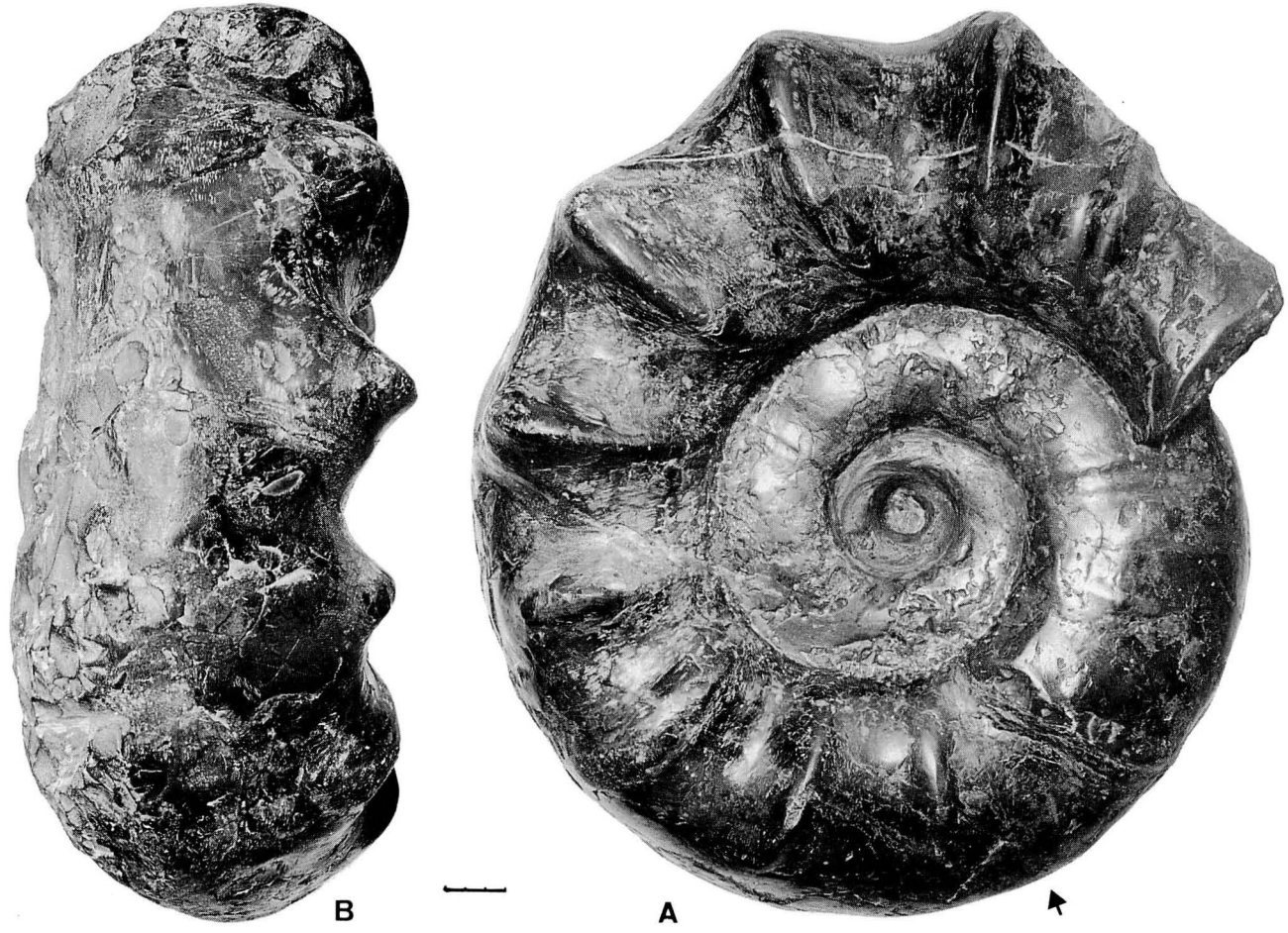


Figure 71. *Hyperpuzosia tamon* sp. nov.
A—B: paratype, YKC. 480628-2 (Pombets 24), from the upper reaches of the Pombets, tributary to the Ikushumbets River (Coll. Y. Kawashita); scale bar = 30 mm.

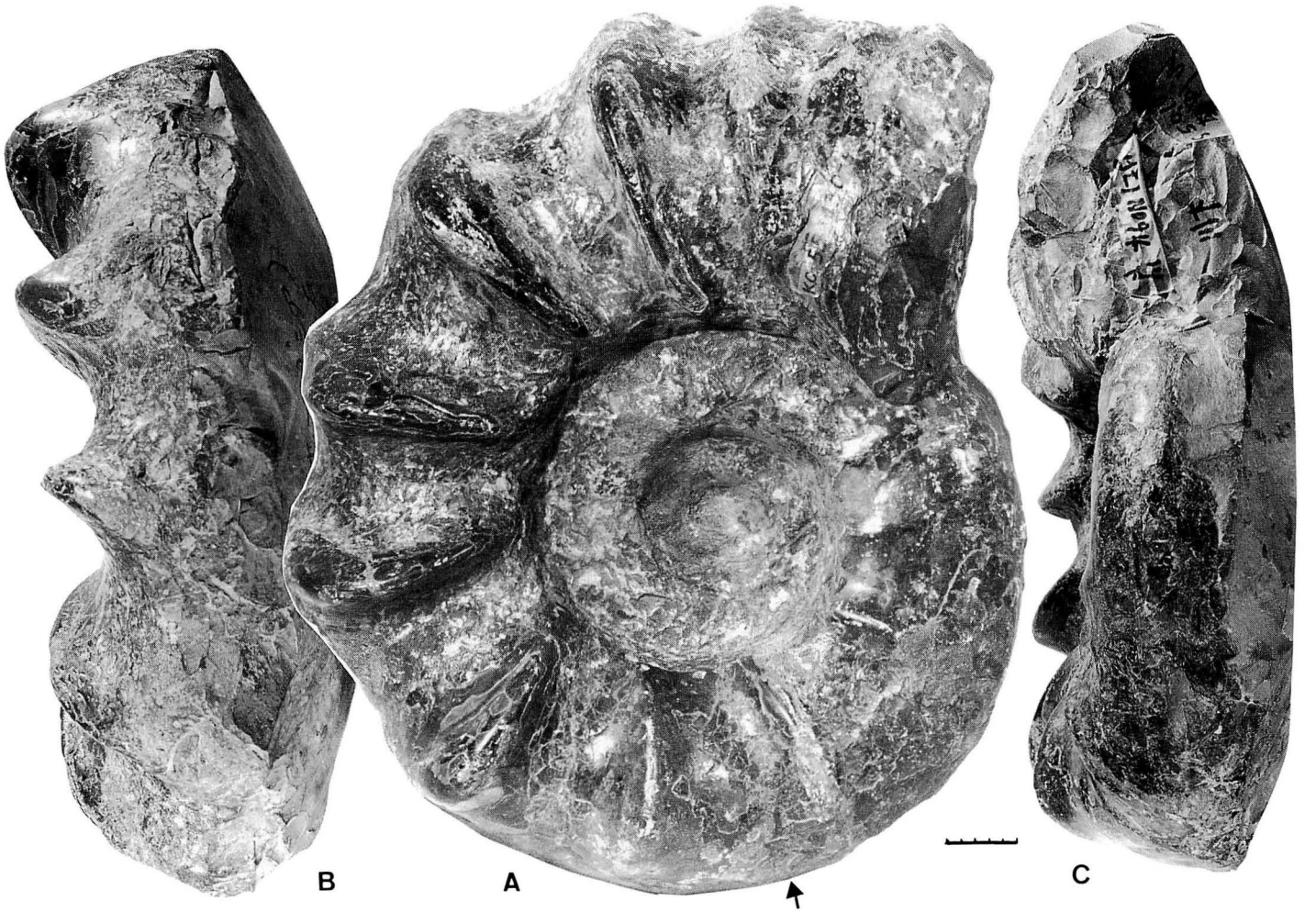


Figure 72. *Hyperpuzosia tamon* sp. nov.
A—C: paratype, YKC. 501005 (Pombets 2) from the upper reaches of the Pombets, tributary to the Ikushumbets River (Coll. Y. Kawashita); scale bar = 50 mm.

Figure 73. *Hyperpuzosia tamon* sp. nov.
A—B: paratype, NSM. MM 9597 from the right gully, upper reaches of the Pombets, tributary to the Ikushumbets River (Coll. Y. Kawashita 551013 Pombets 7; donated to NSM.); scale bar = 50 mm. (Photos by S. Sato).

Dimensions:—

Specimen	D	U	H	B	B/H
Holotype * (c)	470.0 (1)	181.5 (.39)	158.0 (.34)	*c.* 210.0 (.45)	1.33
Holotype ** (ic)	373.0 (1)	119.0 (.32)	142.0 (.38)	*c.* 139.0 (.37)	0.98

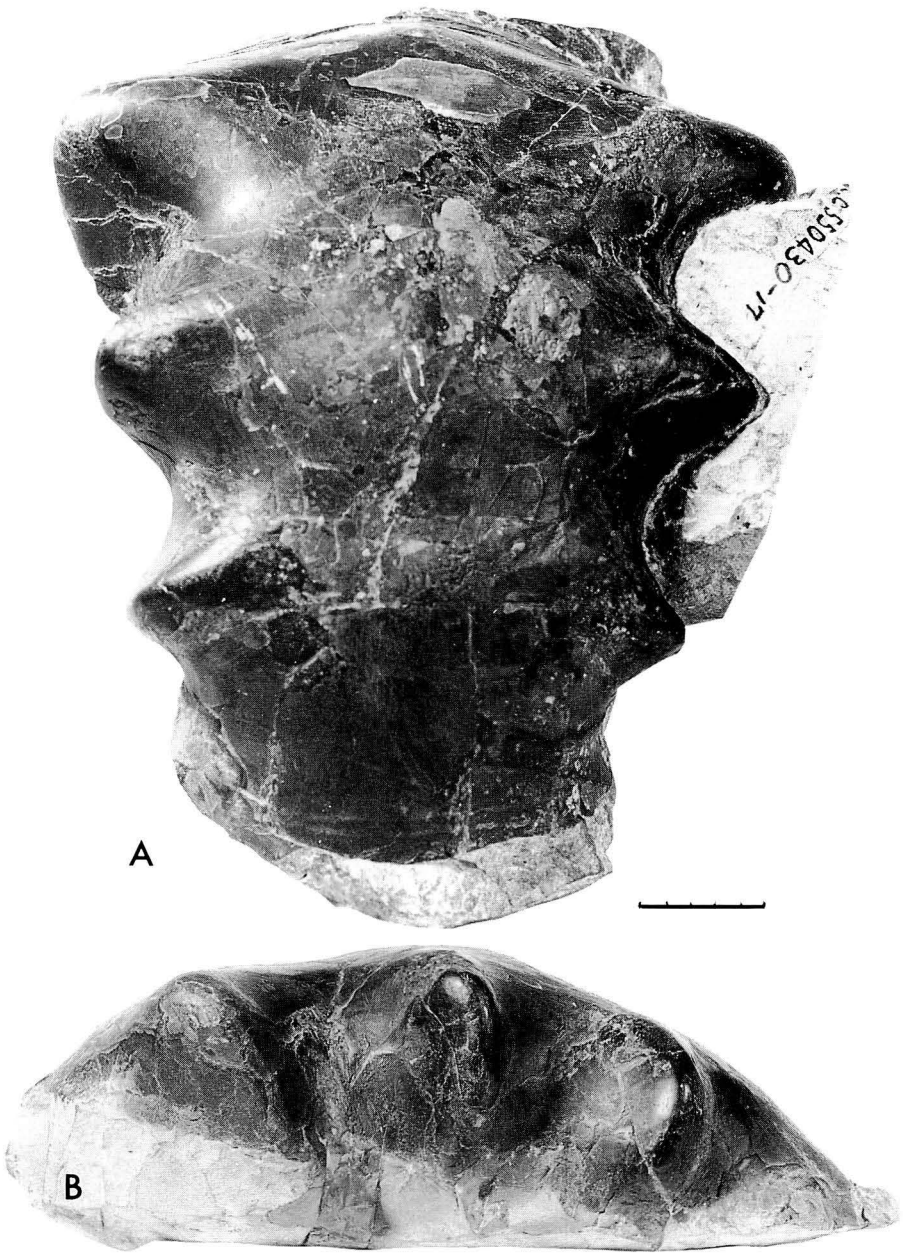


Figure 74. *Hyperpuzosia tamon* sp. nov.
A—B: paratype, YKC. 490927 (Pombets 10) from the upper reaches of the Pombets (Coll. Y. Kawashita). Depressed ventral part of fragmentary body-chamber; scale bar = 50 mm.

Pom. 24 (−90°, c)	441.0 (1)	163.0 (.40)	131.0 (.32)	*c.* 186.0 (.45)	1.42
Pom. 24 (−270°, ic)	*c.* 280.0 (1)	108.0 (.39)	117.0 (.42)	*c.* 122.0 (.44)	1.04
Pom. 2 (ic)	480.0 (1)	185.0 (.39)	175.0 (.36)	—	—
Pom. 2 (c)	485.0 (1)	185.0 (.38)	180.0 (.37)	—	—
Pom. 2 (−90°) (ic)	375.0 (1)	160.0 (.43)	115.0 (.31)	142.0 (.39)	1.23
Pom. 2 (−90°) (c)	390.0 (1)	153.0 (.39)	135.0 (.35)	*c.* 196.0 (.50)	1.45
GK. H8103	*c.* 400.0 (1)	148.0 (.37)	—	—	—
GK. H8103 (−90°) (ic)	—	—	120.0	*c.* 146.0	1.22
GK. H8103 (−115°) (c)	—	—	130.0	*c.* 184.0	1.42
GK. H8104 (LS)	—	—	119.0	*c.* 108.0	0.91
Pom. 5 (c)	490.0 (1)	183.0 (.37)	172.0 (.35)	—	—

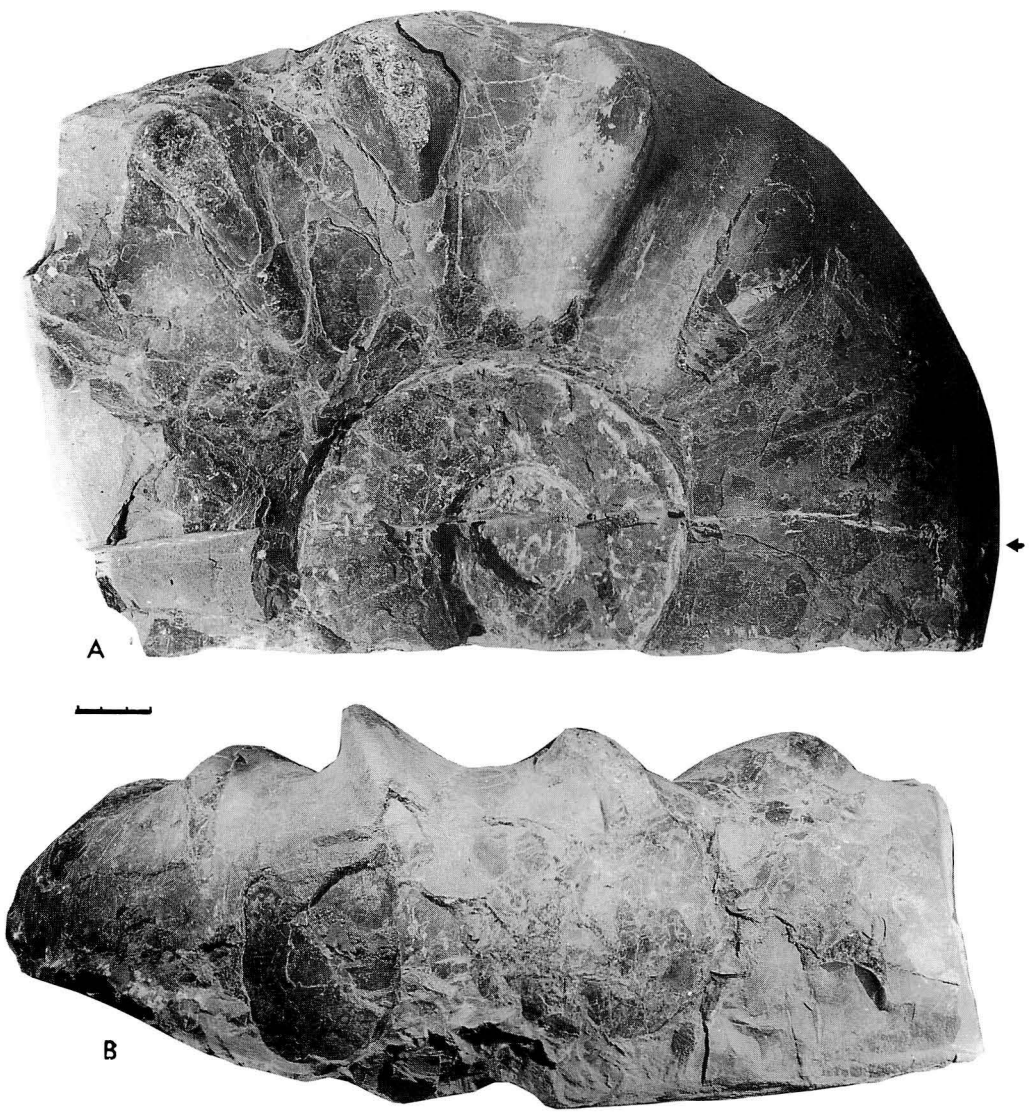


Figure 75. *Hyperpuzosia tamon* sp. nov.
A—B: paratype, GK. H8103 from loc. Ik 2918, upper reaches of the Pombets (Coll. Y. Kawashita and T. Matsumoto); scale bar = 30 mm.

Pom. 5 (−180°) (c)	—	—	135.0	*c.* 147.0	1.09
Pom. 3 (−30°, c)	*c.* 480.0 (1)	196.0 (.41)	147.0 (.31)	—	—
Pom. 3 (−150°, c)	390.0 (1)	147.0 (.38)	133.0 (.34)	150.0	1.13
NSM. 9597 (c)	*c.* 364.0 (1)	123.0 (.34)	135.0 (.37)	*c.* 146.0 (.40)	1.08

* at the last rib, ** at the last septum (*i.e.* end of phragmocone).

Observations:—For the reasons of taphonomic processes the specimens obtained as nodules from the mudstone of Pombets are mostly preserved on one side and the other side remains incompletely or is dissolved away. In an exceptional case the ventral part alone is well exhibited (e.g. Fig. 74), probably on account of a special disposition of embedding. As the preserved half is fairly good, the dimensions, including those of the restored whorl-breadth, are reliable. When the specimen is preserved directly in the mudstone without forming a nodule, it is highly compressed secondarily, as is exemplified by TTC. 370722, but some of the diagnostic features are fairly well impressed.

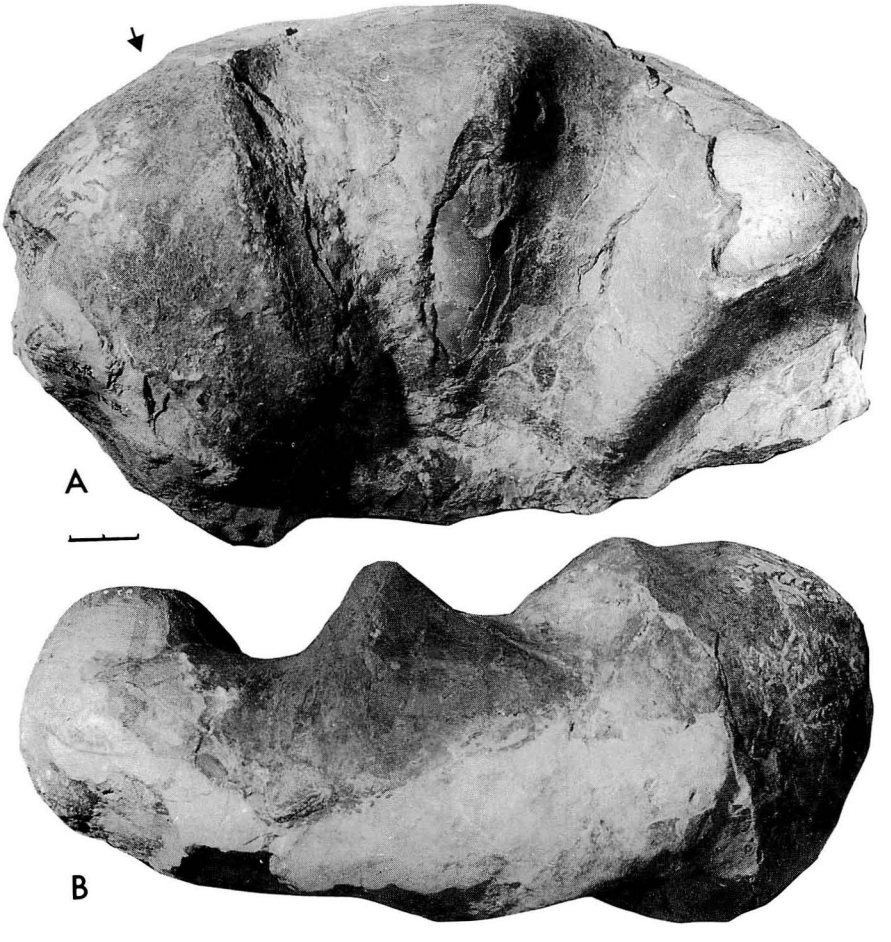


Figure 76. *Hyperpuzosia tamon* sp. nov.
A—B: paratype, GK. H8104 from the upper reaches of the Pombets (Coll. Student of Mikasa High School); bar = 20 mm.

Nearly twenty specimens examined are all large and have the body-chamber which has strong major ribs showing hypernodosity. Therefore, they are adult and probably represent the macroconchs. The body-chamber occupies about 210° to 240° of the last whorl whose maximum

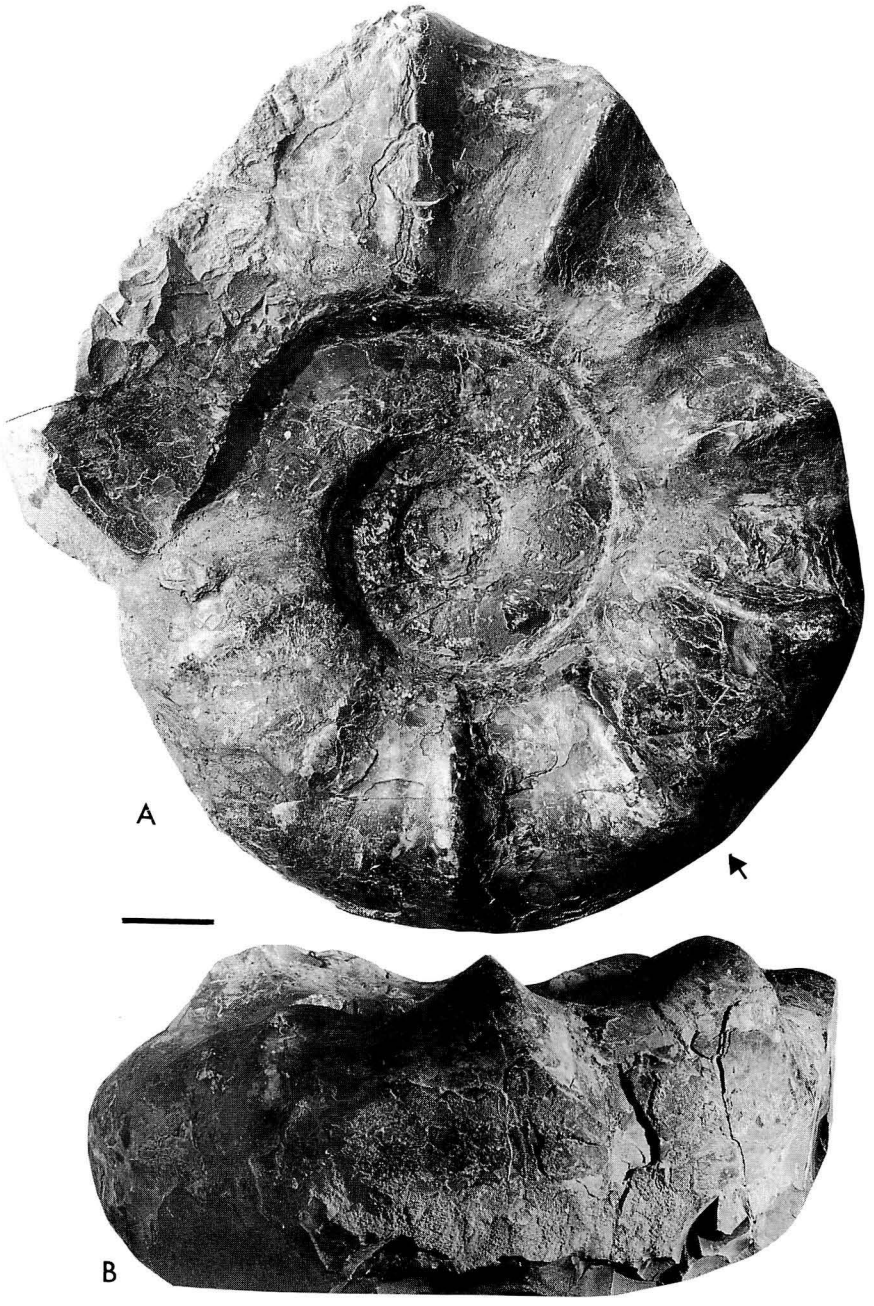


Figure 77. *Hyperpuzosia tamon* sp. nov.
A—B: a form with rectiradiate major ribs, YKC. 560802 (Pombets 5) from the upper reaches of the Pombets (Coll. Y. Kawashita); bar = 50 mm.

diameter varies from 420 mm to 490 mm in the examined specimens.

The diagnostic characters are exhibited fairly constantly. In some specimens the rectiradiate ribs predominate over gently curved ones (e.g. Fig. 77), but such individuals are the minority of the Pombets population. Even in the specimens of the majority, the forward concave curvature of the major ribs is by no means great and some ribs are nearly straight. Therefore we would not separate the species but would call, if necessary, a variety with predominant rectiradiate ribs.

The dimorphism in this species is unknown. We have not yet obtained a representative specimen of the adult microconch which would make a pair with the probable macroconch mentioned above. Is it strongly ribbed on its body-chamber? If not, its difference from the microconch of certain species of *Puzosia* would be morphologically slight. From the analogy with *Anapuzosia*, we would expect a moderately or strongly ribbed microconch, but this should be ascertained by finding a good example.

Comparison:—There is some extent of variation in the ratio B/H in *Puzosia subcorbarica* and a form with comparatively larger B/H (e.g. 0.83 at D=146 of Kera's 161 and 0.78 at D=128 mm of GK. H8105 compared with 0.69 at D=150 mm of the holotype) in a middle-aged macroconch of that species is indeed similar to the phragmocone of this species in shell-form. The former has, however, fairly frequent, well marked and gently sigmoid constrictions. The difference in the adult body-chamber is distinct between the two species. In *P. subcorbarica* gently sigmoid flares persist to the beginning of the body-chamber and the major radial elevations on the main part of the body-chamber are blunt, fading away outward without forming horn-like culminations at the ventrolateral shoulder, and the whorl is ovoid in section without broadening venter.

The illustrated large specimens of Jacob (1908, pl. 16, figs. 2—4) probably represent another species of *Hyperpuzosia,* but without seeing the actual specimens, we cannot define it under a new name. It is probably distinct from *H. tamon* in that the ribs are more typically rectiradiate and disposed at narrower intervals than those of the latter. Its ventrolateral nodes do not seem so markedly stretched laterally as those of ours. It should be noted, however, that the existence of a variety with predominant rectiradiate ribs in our species may suggest an intimate relationship between the two species.

Occurrence:—For the individual localities of the examined specimens see *Material.* At least some of them are certainly in the overturned anticlinal belt bounded on both sides by thrusts. That area is occupied by Unit Ma of K. Tanaka (*in* Matsuno *et al.*, 1964). This unit is, in Matsumoto's view, assigned to the upper part of the Lower Yezo Group. *Ammonoceratites ezoensis* (Yabe) (a questionable synonym of *A. mahadeva* (Stoliczka) according to Kennedy and Klinger, 1978, p. 299) is commonly associated with *H. tamon,* but no guide species has been found together with them.

There is, however, *Lyelliceras* cf. *lyelli* (d'Orbigny) in Unit Ma. This specimen, GK. H5425 (Fig. 78B—C) was obtained by T. Muramoto singly at an isolated locality in a small gully to the south of Nishi-katsura-zawa, where the mudstone of Unit Ma is extended from the Pombets. There is another specimen, TTC. 450605 (Fig. 78A), which was found by T. Takahashi from loc. Ik 2064, outcrop of the mudstone (Unit Md) immediately above the basal sandstone (Unit Mc) of the Middle Yezo Group in the Onko-no-sawa. It is identified by Matsumoto and Takahashi with *Dipoloceras pseudaon* Spath. Takahashi obtained from the same rock a small specimen of *Marshallites* sp. and a poorly preserved *Marshallites* sp. is also contained in the body-chamber

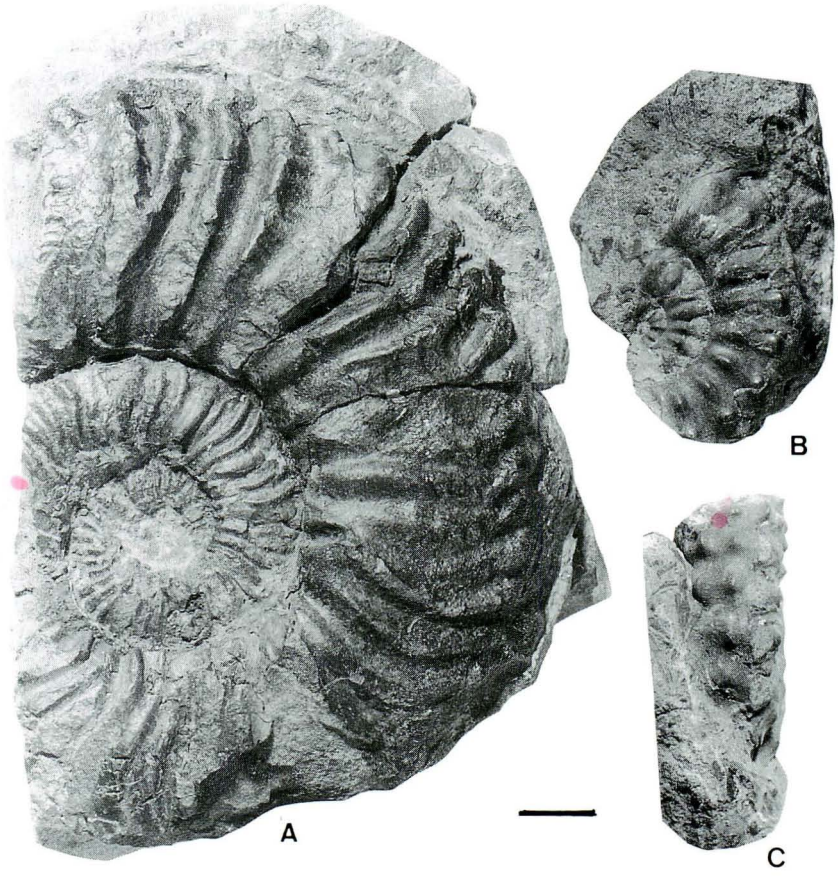


Figure 78. Two ammonites found from a higher level (A) and on the extension (B—C) of the member of mudstone with *Hyperpuzosia tamon*.
A: *Dipoloceras pseudaon* Spath, TTC. 450605 from the Onko-no-sawa (loc. 4567), branch of the Pombets (Coll. T. Takahashi); B—C: *Lyelliceras* cf. *lyelli* (d'Orbigny), GK. H5425 (=MC. 2036), from a gully south of Shimo-katsura-zawa, Ikushumbets Valley (Coll. T. Muramoto, donated to GK.). Bar=10 mm.

of the holotype of *H. tamon,* although some species of *Marshallites* may be long-ranging. Another indirect age indicator is *Douvilleiceras* sp., which is found occasionally as fragmentary pieces in pebbles of the upper reaches of the Pombets. They must have come from somewhere in the Lower Yezo Group.

To sum up, we are inclined to consider that *Hyperpuzosia tamon* characterizes Unit Ma of the Pombets valley together with *Ammonoceratites ezoensis.* Its age is probably Lower Albian, although the species may range somewhat upward. Anyhow, we should search for more reliable evidence for the stratigraphic occurrence of this species.

Genus *Pteropuzosia* Matsumoto, nov.

Pteropuzosia kawashitai sp. nov.

(By Tatsuro Matsumoto)

Figures 79—84

Material:—Holotype, YKC. 540610 (Fig. 79), obtained by Y. Kawashita at a point about 900 m upstream from the entrance of a small stream, called the 66-rimpan-zawa (see Tanabe *et al.* 1977, fig. 8), southeast of Tengu-bashi (a bridge across the main stream of the River Obirashibe), mudstone of Member Mj-k, Middle Yezo Group (see Tanaka, 1963 and Tappu Quadrangle by Tsushima *et al.*, 1958).

Illustrated paratypes, GK. H8096 (Fig. 80) from loc. T1080p, probably derived from the mudstone of IId2, middle part of the Saku Formation in the Saku-gakko-no-sawa, Teshio Mountains (Coll. T. Muramoto and T. Matsumoto); YKC. 610801 (Fig. 81; Fig. 82A) from loc. Y5154, YKC. 580724 (Fig. 82B; Fig. 83) from loc. Y5155p and YKC. 531007 (Fig. 84) from loc. Y5155r, the above three in the Taki-no-sawa (sometimes called the River Penke-moyuparo), layers of mudstone with *Mytiloides mytiloides* (Mantell) and *M.* cf. *hercynicus* (Petracheck), Oyubari area (the above three Y. Kawashita Coll.).

Other fragmentary specimens referable to this species; GK. H8098 from loc. H2336p, small stream on the east side of the artificial lake of Hobetsu dam (T. M. Coll.); GK. H8318 from loc. R5203 and GK. H8319 from loc. R6227, Member Mj or Mj-k of the Obira area (see Tanabe *et al.*, 1977).

No. 432 of M. Kera Collection, which he has recently obtained from the River Yubari (now dammed to form the Lake Shuparo) and kindly showed me, is a good example of this species (see list of dimensions).

Diagnosis:—Shell gigantic, with low to moderate rate of whorl expansion, moderate involution and umbilicus of moderate width.

Main part of the phragmocone fairly higher than broad, with narrowly arched venter and low but steep umbilical wall, ornamented with numerous, alternately long and short ribs which are nearly rectiradiate or slightly prorsiradiate on the inner flank and gradually but gently curved forward on the outer flank; periodic constrictions shallow and associated flares rather weak.

On the last part of the phragmocone and at the beginning of the body-chamber, ribs weaken, remaining on the outer part, and then disappear; whereas broad but very low, major radial bulges appear and shallow constrictions or weak flares may persist. The main part of the body-chamber provided with at least two pairs of wing- or large ear-like protuberances on which several coarse ribs are superimposed and may form nodes at the ventrolateral edge, the wings stretch laterally (i.e. perpendicular to the flank) at the ventrolateral shoulder and where the wings develop, the body-chamber itself much broadens, with the umbilical wall becoming very high and steep. The interspace between the first and the second wings concave, where the body-chamber is also narrowed. A blunt keel-like elevation appears along the median line of the venter.

Dimensions:—

Specimen	D	U	H	B	B/H	H/h
Holotype (E–20°)	572.0 (1)	201.0 (.35)	206.0 (.36)	*c.* 140 (.24)	0.68	1.25
Holotype (W2)	552.0 (1)	188.0 (.34)	206.0 (.37)	*c.* 230 (.42)	1.12	—

Holotype (W1)	—	—	188.0	*c.* 240.0	1.28	—
Holotype (LS)	460.0 (1)	143.0 (.31)	173.0 (.38)	*c.* 140.0 (.30)	0.81	1.21
Kera 432 (W1)	584.4 (1)	189.0 (.32)	252.0 (.43)	*c.* 340 (.58)	1.35	—
Kera 432 (LS)	480.0 (1)	148.0 (.31)	192.0 (.4)	*c.* 150 (.31)	0.78	1.37
Kera 432 (LS–110°)	—	—	146.0	94.0	0.64	—
YKC. 610801 (E)	645.0 (1)	261.0 (.40)	206.0 (.32)	*c.* 120 (.19)	0.58	1.16
YKC. 610801 (W1)	—	—	*c.* 204	*c.* 267	1.31	—
YKC. 610801 (LS)	520.0 (1)	176.0 (.34)	181.0 (.35)	*c.* 120 (.23)	0.66	1.11
YKC. 531007 (W1)	570.0 (1)	201.0 (.35)	195.0 (.34)	*c.* 236 (.41)	1.21	1.12
YKC. 531007 (LS)	476.0 (1)	159.0 (.33)	180.0 (.38)	*c.* 146 (.31)	0.82	1.29
GK. H8096 (W1)	—	—	*c.* 223	*c.* 283	1.27	—

Abbreviations indicating the positions of measurements: E = preserved end, W1 and W2 = the first and the second wing-like protuberances. LS = last suture. YKC. 610801 is secondarily compressed and distorted, but measured as it is.

Observations:—The body-chamber is preserved for nearly 180° in the holotype and has two pairs of large ears (wings) within this half whorl. In other specimens the body-chamber is more or less incompletely preserved, showing only the first pair of wings. For example, Kera's no. 432 preserves the body-chamber for about 100° and has the first pair of wings near its preserved end. It has, however, a trace of the lost part of the body-chamber for another 95°, which is sufficient to allocate the second pair of wings. The length of the body-chamber for 195° may be short but would be sufficient to keep balance with the phragmocone, if the difference in the whorl-breadth is considered.

The holotype exemplies the huge size of this species, as it is nearly 580 mm in the maximum diameter. As its last part up to the apertural margin is not preserved, the original shell may have been somewhat greater than this dimension. YKC. 610801 is 645 mm at the preserved end of the first pair of wings, but it is secondarily compressed and somewhat distorted. YKC. 580714, another specimen from the nearby locality, is awfully distorted and depressed. It measures 730 mm along the elongated axis of deformation, but may be 640 mm or so in a restored outline. The less deformed Kera's specimen no. 432 mentioned above is 584 mm in diameter at the preserved end of the first wing. It must have been at least 640 mm in diameter when the body-chamber was complete.

To sum up, the diameter of the entire adult shell of this species ranges so far from 580 mm to 650 mm and that at the end of the phragmocone from 460 mm to 520 mm. (See table of dimensions.)

The umbilicus is of moderate breadth, U/D being normally between 0.31 and 0.35. Too large ratio in YKC. 610801 owes probably to the secondary distortion which also has produced an apparent decrease in whorl-height. The outer whorl overlaps about or somewhat less than a half of inner whorl in height.

There is some variation in the detailed features of the ornament on the body-chamber. For instance, the ribs and nodes are coarser and stronger in GK. H8096 than those in the holotype. The first wing-like protuberance appears somewhat later in YKC. 610801 than that in the holotype. Besides the periodic weak flares on the early part of the outer whorl, a few coarse ribs may appear before the development of the wing, as seen in YKC. 531007 (Fig. 84). Anyhow, I should regard these minor differences in ornament as variations within a species.

Comparison and discussion:—As I mentioned in the description of the genus, the main part of the phragmocone of this species is similar to that of *Mesopuzosia* sp. In my present knowledge,

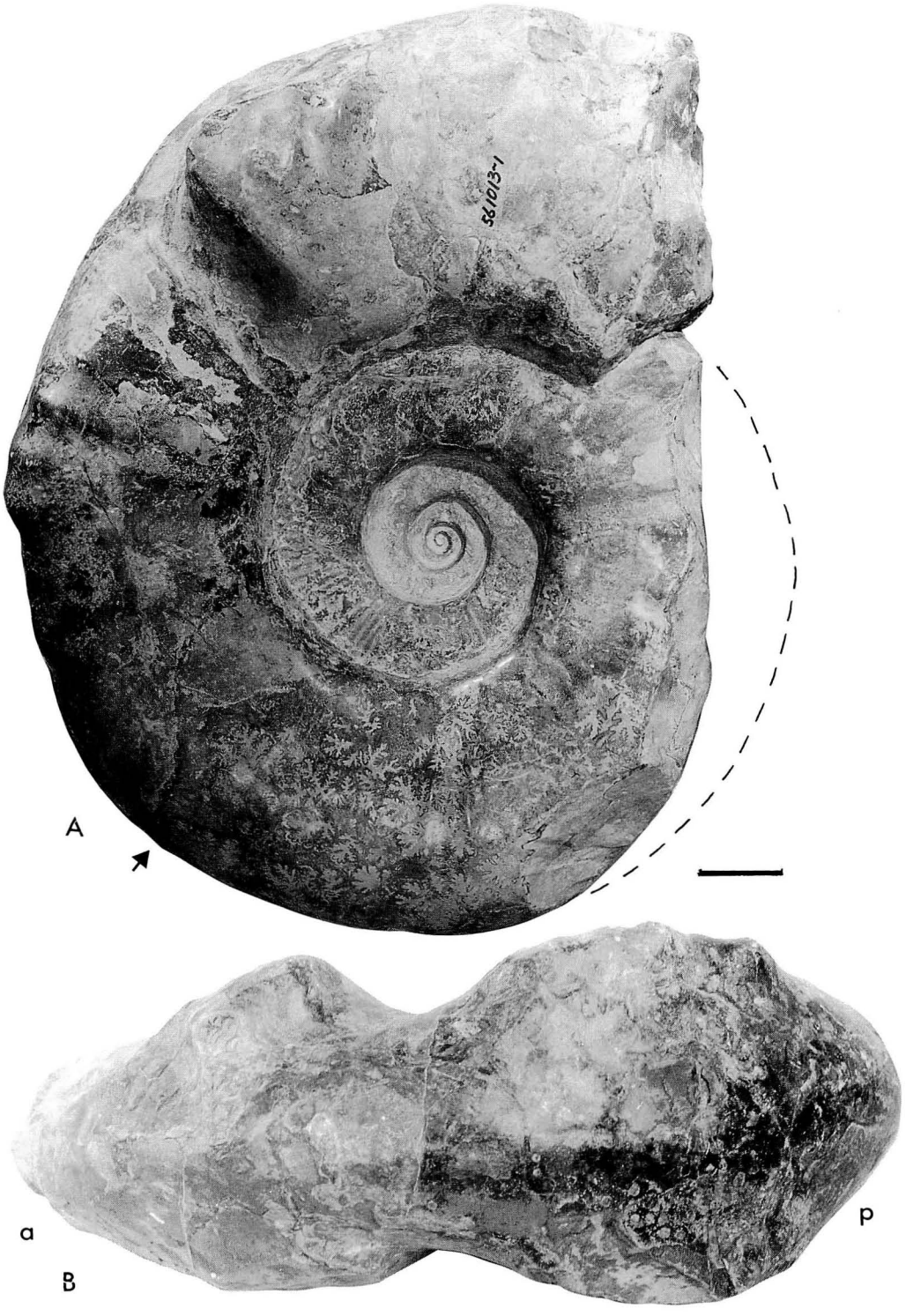


Figure 79. *Pteropuzosia kawashitai* sp. nov.
A—B: holotype, YKC. 540610 from southeast of Tengu-bashi, the Obirashibe Valley (Coll. Y. Kawashita); bar = 50 mm. a = anterior, p = posterior.

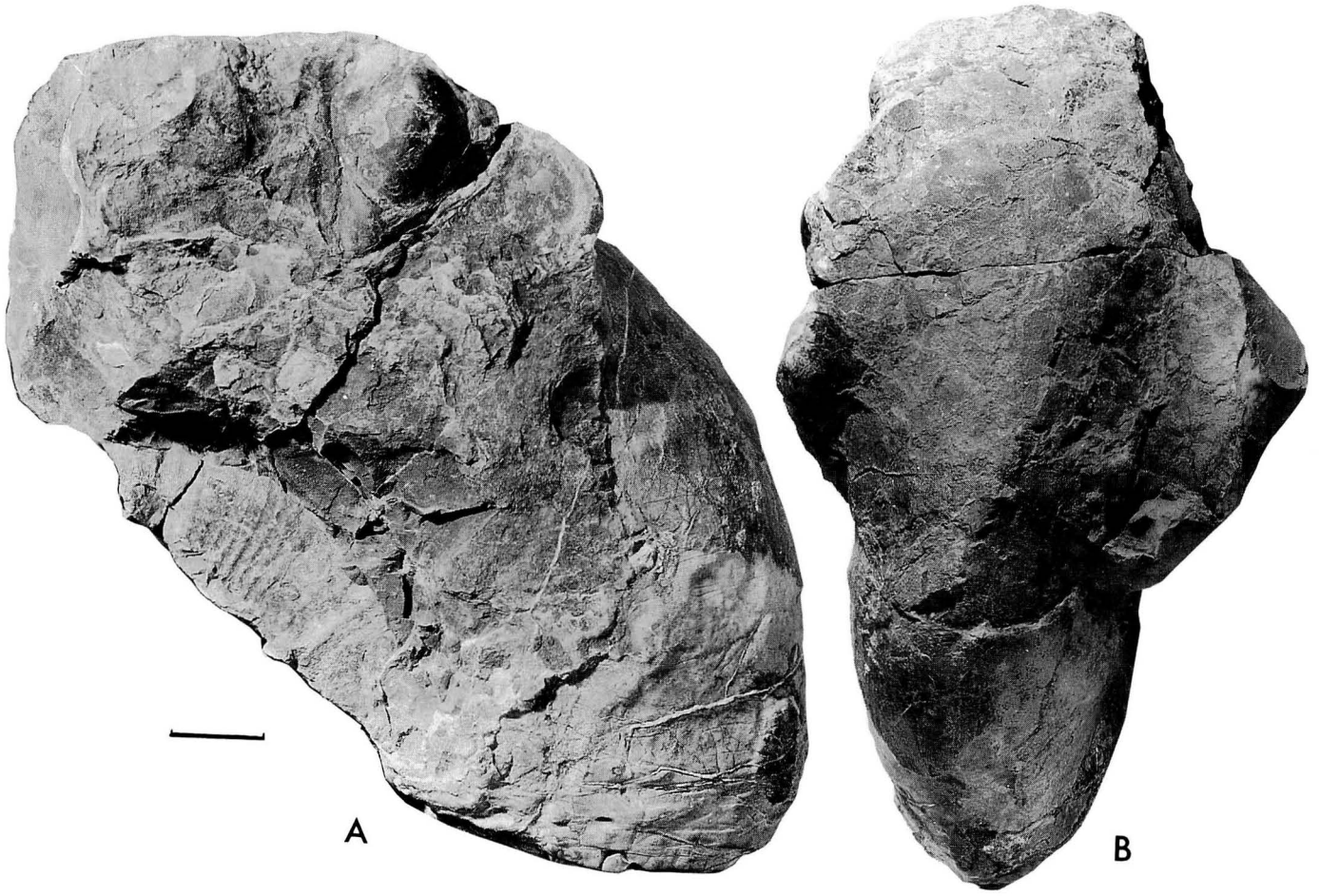


Figure 80. *Pteropuzosia kawashitai* sp. nov.
A—B: paratype, GK. H8096 from loc. T1080p, Saku area (Coll. T. Muramoto and T. Matsumoto); bar = 50 mm for A; B is somewhat more reduced than A.

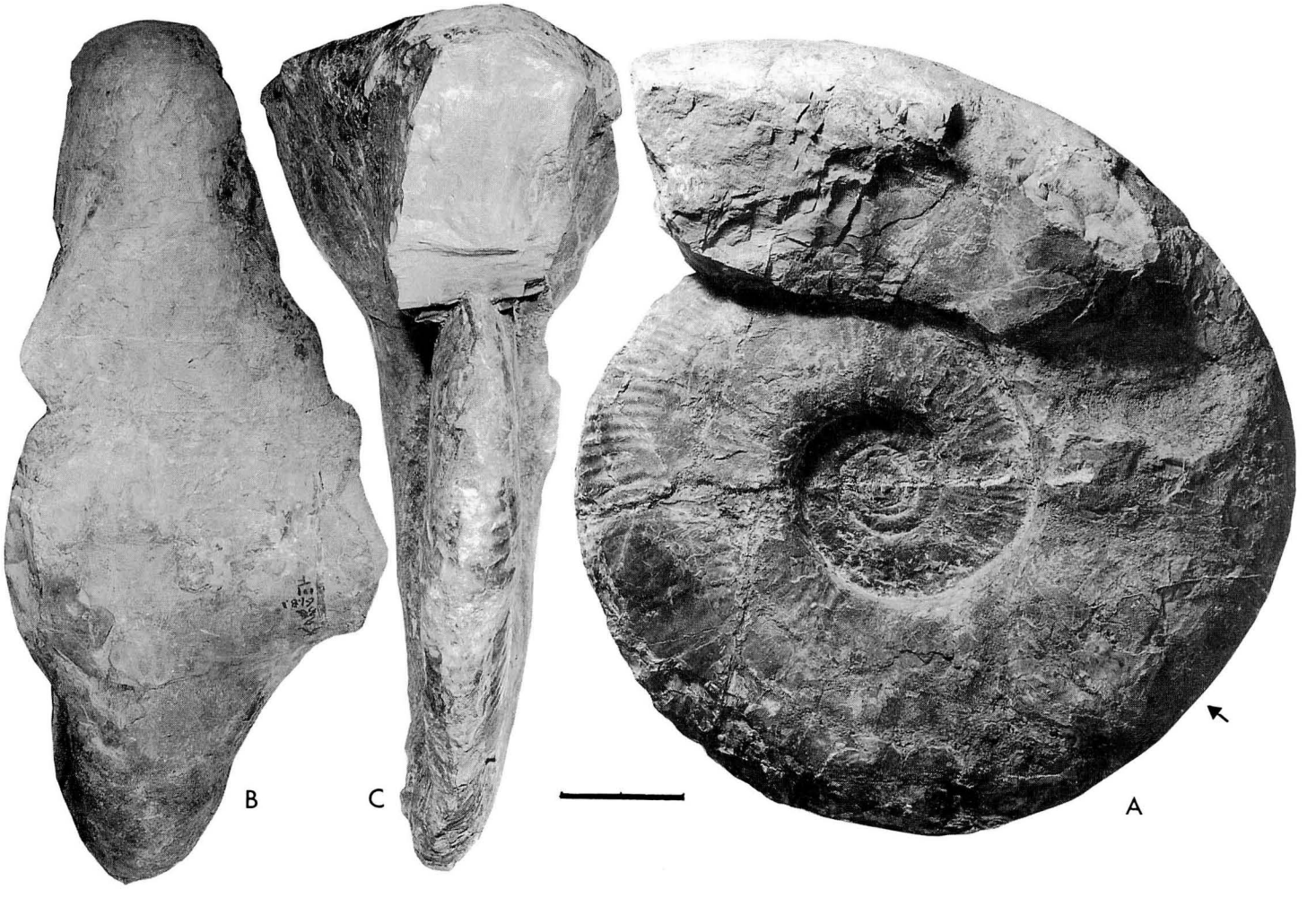


Figure 81. *Pteropuzosia kawashitai* sp. nov.
A—C: paratype, YKC. 610801 from loc. Y5153, Taki-no-sawa, Oyubari area (Coll. Y. Kawashita with M. Noda and T. Matsumoto); scale bar = 100 mm.

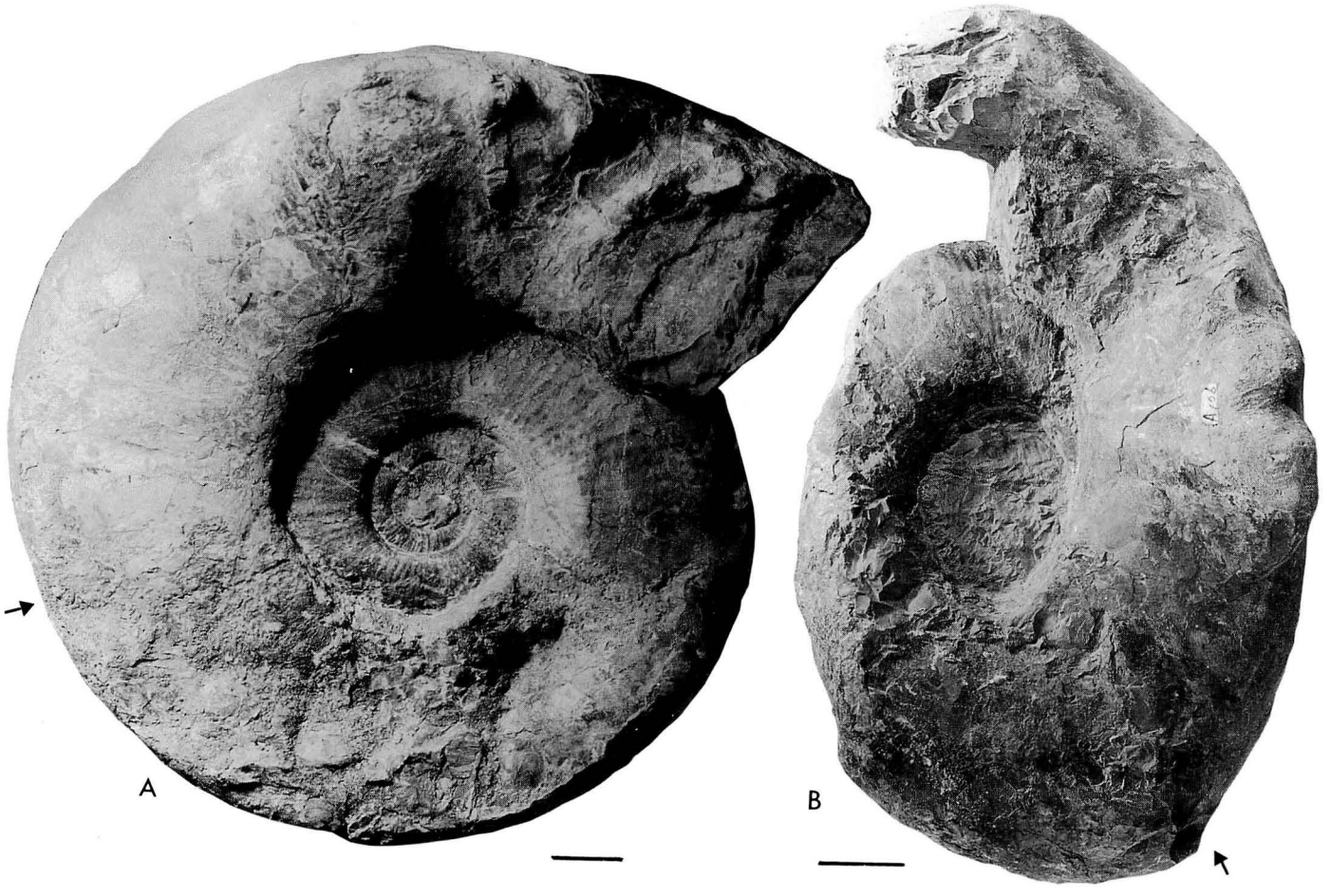


Figure 82. *Pteropuzosia kawashitai* sp. nov.
A: paratype, YKC. 610801, same as Fig. 81A—C bar = 50 mm. B: paratype, YKC. 580724, same as Fig. 83A—C; bar = 50 mm.

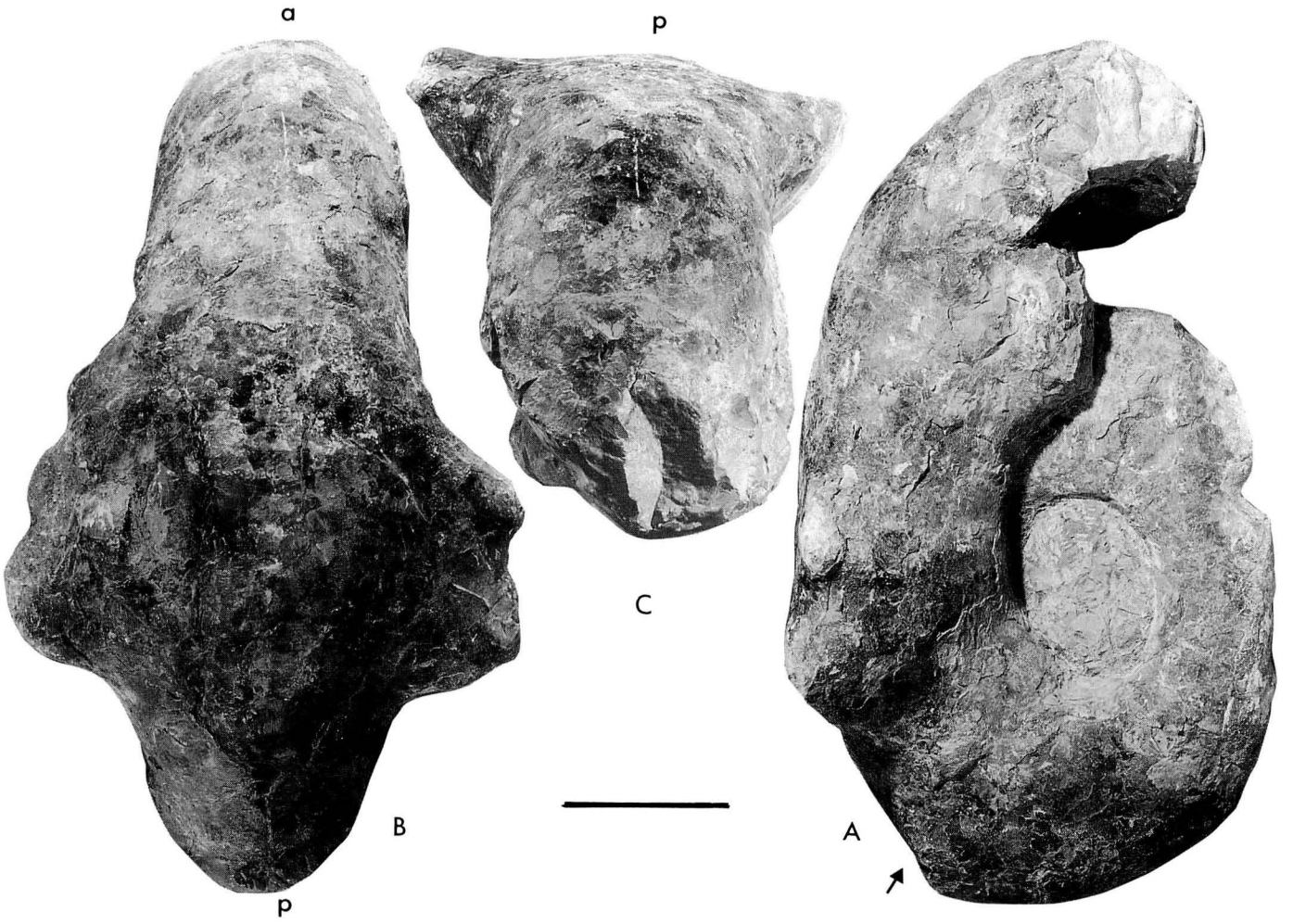


Figure 83. *Pteropuzosia kawashitai* sp. nov.
A—C: paratype, YKC. 580724 (= MCM. A106) from loc. Y5155p. Taki-no-sawa, Oyubari area (Coll. Y. Kawashita, donated to MCM.); bar = 100 mm. Specimen depressed and deformed secondarily. C is in a particular view. a = anterior, p = posterior.

Figure 84. *Pteropuzosia kawashitai* sp. nov.
A—B: paratype, YKC. 531007 from the Taki-no-sawa, Oyubari area (Coll. Y. Kawashita); bar = 50 mm. Only the left half is preserved.

however, it is difficult to point out precisely what species of *Mesopuzosia* is most closely allied to *Pteropuzosia kawashitai*. *M. pacifica* has distinctly sigmoidal ribs and less compressed whorls with less narrowly arched venter. *M. takahashii* can be regarded as being more similar to this species in the mode of ribbing and compressed whorl in its late growth-stage but has a distinctly

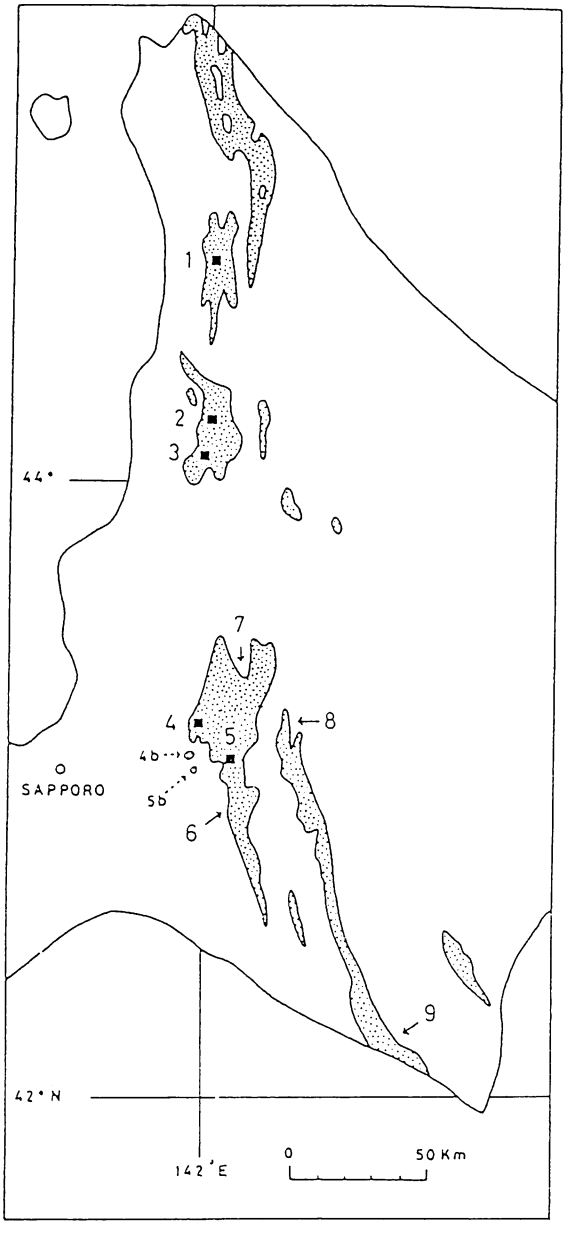


Figure 85. Map of the meridional belf of Hokkaido.
Dotted: outcrop area of the ammonite bearing Cretaceous deposits. 1: Saku-Abeshinai, 2: Haboro-Kotanbetsu, 3: Obirashibe Valley, 4: Ikushumbets Valley or Mikasa area, 4b: Manji, 5: Oyubari (Shiyubari-Oyubari). 5b: Yubari, 6: Hobetsu-Hetonai, 7: Ashibetsu, 8: Furano, 9: Urakawa. ■ Stratigraphic section shown in Matsumoto *et al.*, 1978.

narrower umbilicus. As the available specimens of *P. kawashitai* are all large, I do not know whether its characters in younger stages are similar to those of *M. takahashii* or otherwise.

The similarity of this species with *Puzosia orientalis* in the septate stage should not be overlooked, but the long ribs do not develop well in the latter.

The dimorphic pair has not yet been confirmed for this species. The early half of the large outer whorl resembles the outer whorl of certain species of *Puzosia* and *Mesopuzosia* in the smoothed surface with faintly remained periodic constrictions or flares and bluntly appeared low and broad major undulations. This fact and the broadening of the body-chamber allow us to interpret that the described large form represents a macroconch. I obtained at loc. Y5156 (right side of the Taki-no-sawa, Oyubari area) a smaller specimen (GK. H8317) which resembles the inner whorl of this species in having constrictions, numerous long ribs and moderately wide umbilicus. It was in the same mudstone which contains a large shell having large ear-like protuberance. The beds exposed on the steep cliff of loc. Y5156 are on the northern extension of those at loc. Y5154, where a figured specimen (YKC. 610801) was obtained. Therefore that smaller specimen may be a microconch of this species. Its ribs are projected on outer part; most of them arcuate on flank but some sigmoidal. I should search for a better preserved specimen which shows the apertural margin. Anyhow, I presume that the microconch of this species would be fairly similar to that of *Mesopuzosia* sp., but a careful comparison of macroconchs enables us to distinguish the species.

From the general aspect of the broadened body-chamber, someone might regard this species as a derivative from some species of *Pachydesmoceras.* In fact several species of *Pachydesmoceras* has alternately long and short ribs which are simply arcuate (i.e. concave forward in lateral view). In *Pachydesmoceras* species, however, ribs coarsen or strengthen gradually with growth, showing

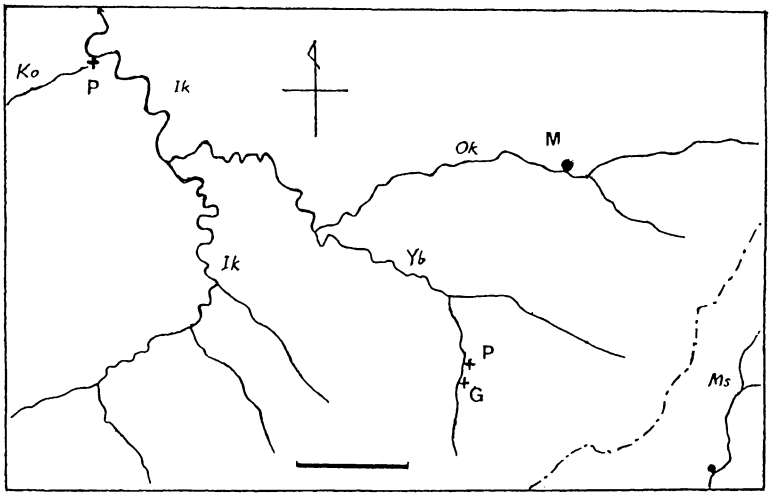


Figure 86. Map of the upper reaches of the River Ikushumbets.
Ik: Main stream of the Ikushumbets, Ko: Koya-no-sawa, Ms: Masago-zawa (tributary to the River Shiyubari), Ok: Oku-hidarimata-zawa, Yb: Yubari-goe-no-sawa, • M: Locality Ik 8304 where huge macroconch of *Mesopuzosia yubarensis* was obtained, + P: *Pachydesmoceras mihoense,* + G: "*Sornayceras*" or *Gauthiericeras*; chain: watershed. Lower left corner of map: N 43° 10', E 142° 3'. Scale bar = 1000 m.

ventral projection and the whorl broadens also rather gradually. Such characters are not seen in *Pt. kawashitai,* in which ribs are dense and fine until they fade away on the outer whorl and even the body-chamber is not much inflated where the wing-like protuberances do not exist.

Occurrence:—The Turonian (probably lower to middle part) of the Obira-Saku area, Teshio Mountains (northwestern Hokkaido) and the upper Lower Turonian in the Oyubari-Hobetsu area, Yubari Mountains (central Hokkaido).

Although the specimens listed above are not numerous, during the field work in the Teshio and Yubari Mountains I saw more or less incomplete but large and characteristic specimens which are referable to this species. Y. Kawashita told me the same experience. Therefore this species is by no means rare in the Turonian strata of Hokkaido.

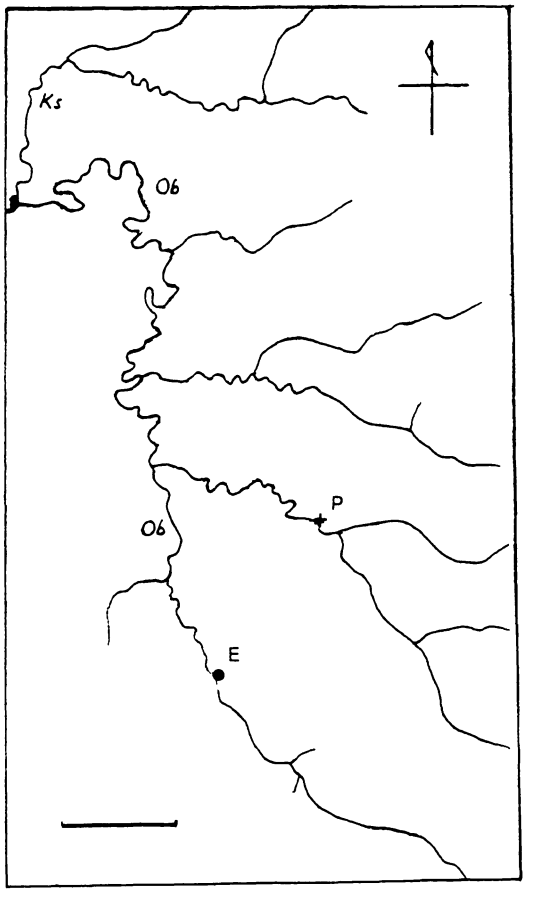


Figure 87. Map of the upper reaches of the Obirashibe.
• E: *Epipuzosia maya* (type loc. R8024 on Ob; paratypes loc. R2101 on Ks), + P: *Pachydesmoceras* aff. *kossmati,* Ob: main stream of the Obirashibe, Ks: Kanajiri-zawa. Upper left corner of map: N 44° 7', E 142° 0'. Scale bar = 1000 m.

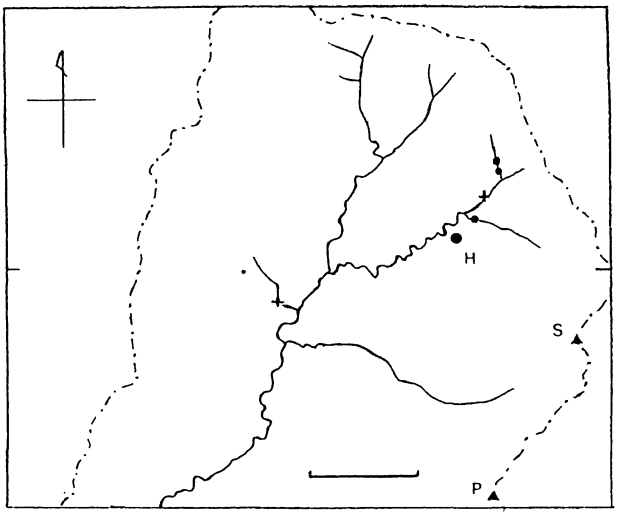


Figure 88. Map of the upper reaches of the Pombets, tributary to the River Ikushumbets.
• H: type locality of *Hyperpuzosia tamon,* •: other nearby locality of *H. tamon,* + ditto (fallen or floated); chain: watershed, P: summit of Mt. Pombets-dake, S: Sakai-yama, Mid-point of the right line of map: N 43° 20', E 142° 4'. Scale bar = 1000 m.

Place Names

Abeshinai 安平志内, Aikawa 相川, Ashibetsu 芦別, Ban-no-sawa 盤ノ沢, Deto-futamata-gawa デト二股川, Fukuoka 福岡, Furana 富良野, Futaba 双葉, Haboro 羽幌, Hachigatsu-zawa 八月沢, Hakkin-gawa or Hakkin-zawa (sometimes called Shirokin-gawa) 白金川：白金沢, Hetonai 辺富内, Hikage-zawa 日陰沢, Hinata-zawa 日向沢, Hobetsu 穂別, Hokkaido 北海道, Ikushumbets (Ikushunbetsu) 幾春別, Isojiro-no-sawa 磯次郎ノ沢, Kami-kinembets (Kami-kinenbetsu) 上記念別, Kanajiri-zawa 金尻沢, Kaneobets (Kaneobetsu)金尾別（カネオベツ), Karasemi-zawa 空蟬沢, Kashima 鹿島, Katsura-zawa 桂沢, Kawakami 川上, Kochi 高知, Kotanbetsu 古丹別, Koya-no-sawa小屋ノ沢, Machiyoi-zawa 待宵沢, Magari-zawa 曲沢, Masago-zawa 真砂沢, Migi-mata-zawa 右股沢, Miho 美保, Mikasa 三笠, Monobe-gawa 物部川, Mukawa 鵡川, Naibuchi 内淵, Naka-kinembets 中記念別, Naka-no-futamata-gawa 中ノ二股川, Nambu-zawa 南部沢, Nishi-katsura-zawa 西桂沢, Obira 小平, Obirashibe 小平蘂, Ohmaki-zawa 大巻沢, Oidaira 大井平, Oku-futamata-gawa 奥二股川（小平), Oku-futamata-zawa 奥二股沢（奔別), Oku-hidarimata-zawa (Oku-samata-zawa) 奥左股沢, Onko-no-sawa オンコノ沢, Oyubari 大夕張, Panke-moyuparo (Panke-moyubari) パンケモユーパロ, Penke-moyuparo (Penke-moyubari) ペンケモユーパロ, Pombets (Ponbetsu) 奔別, Pombets-Go-no-sawa 奔別五ノ沢, Poroko-ashibetsu 幌子芦別, 163 Rinpan-no-sawa 163林班ノ沢, Sakai-yama 境山, Saku 佐久, Saku-gakko-no-sawa 佐久学校ノ沢, Sapporo 札幌, Sato-no-sawa 佐藤ノ沢, Sendai 仙台, Shihorokabets 志幌加別, Shimo-katsura-zawa 下桂沢, Shirochi-une-zawa 白地畝沢, Shuyubari (Shiyubari) 主夕張（シユウバリ), Shuparo シュウパロ, Sorachi 空知, Suido-no-sawa 水道ノ沢, Taki-no-sawa 滝ノ沢, Tengu-bashi 天狗橋, Teshio 天塩, Tokyo 東京, Tomatsu 唐松, Tomiuchi 富内, Tosa 土佐, Urakawa 浦河, Yayoi 弥生, Yoshiachi-zawa ヨシアチ沢, Yubari 夕張, Yubari-goe-no-sawa 夕張越ノ沢, Yu-no-sawa 湯ノ沢

References Cited

Anderson, F. M. (1938): Lower Cretaceous deposits in California and Oregon. *Geol. Soc. Amer. Spec. Pap.*, **16:** 339 pp., 84 pls.

——— (1958): Upper Cretaceous of the Pacific Coasts. *Geol. Soc. Amer. Memoir* **71**, 378 pp., 75 pls.

Arkell, W. J., Kummel, B. and Wright, C. W. (1957): Mesozoic Ammonoidea. *In* Moore, R. C. (ed.): *Treatise on Invertebrate Paleontology, Part L, Mollusca 4,* Cephalopoda Ammonoidea, L80—L465. Geol. Soc. Amer. & Univ. Kansas Press.

Arkhanguelsky, A. D. (1916): Mollusques du Crétacé superieur de Turkestan. *Mém. Com. Géol. Petrograd.*, [N.S.], **152**, i—vi, 1—57, pls. 1—8.

Bayle, E. (1878): Fossiles principaux des Terrains. *Explic. Carte Geol. France,* **4**, Part I (Atlas), 158 pls., Paris.

Beskovski, S. (1977): Sur la classification de la famille Desmoceratidae Zittel, 1895 (Ammonoidea, Crétacé). *C. R. Akad. Bulg, Sci.*, **30**, (6), 891—894.

Boule, M., Lemoine, P. and Thévenin, A. (1906—1907): Paléontologie de Madagascar. 3 — Céphalopodes crétacé des environs de Diego-Suarez. *Ann. Paléont.*, **1**, 173—192 (1—20), pls. 14—20 (1—7) (1906); *Ibid.*, **2**, 1—56 (21—76), pls. 1—8 (8—15) (1907).

Breistroffer, M. (1947): Sur les zones d'ammonites dans l'Albien de France et d'Angletere. *Trav. Lab. Géol., Fac. Sci., l'Univ. Grenoble* (1946—47), **26**, 17—104.

Buch, L. von (1850): Die Anden in Venezuela. *Zeitsch. deutsch. Geol. Ges.*, **2**, 339—345, pl. 10.

Chatwin, C. P. and Withers, T. H. (1909): Contribution to the fauna of the Chalk Rock. *Geol. Mag.* [5], **6**, 66—68, pl. 2.

Choffat, P. (1903): Contribution à la connaissance géologique des Colonies Portugaises d'Afrique. I. Le Crétacique de Conducia. *Mém. Com. Serv. Géol. Portugal,* 1—32, pls. 1—8, frontispiece.

Collignon, M. (1932): Paléontologie de Madagascar. 17-Fossiles du Crétacé supérieur du Ménabe. *Ann. Paléont.*, **21**, 35—87, pls. 4—12 (1—9).

——— (1950): Recherches sur les faunes albiennes de Madagascar. 4. L'Albien de Mokaraha (cercle de Soalala). *Ann. Geol. Serv. Mines, Madag.*, **17**, 55—85, pls. 10—14.

——— (1961): Ammonites néocrétacees du Menabe (Madagascar). 7— Les Desmoceratidae. *Ann. Géol. Serv. Mines, Madag.*, **31**, 1—115, pls. 1—32.

——— (1963): *Atlas des Fossiles caracteristique de Madagascar* (*Ammonites*), **10** (Albien), i—xv, 1—184, pls. 241—317. Serv. Géol. Repub. Malag., Tananarive.

——— (1964): *Atlas des Fossiles caracteristique de Madagascar* (*Ammonites*), **11** (Cénomanien), i—xi, 1—152, pls. 318—375. Serv. Géol. Repub. Malag., Tananarive.

——— (1965a): *Atlas des Fossiles caracteristique de Madagascar* (*Ammonites*), **12** (Turonien), i—iv, 1—82, pls. 376—413. Serv. Géol. Repub. Malag., Tananarive.

——— (1965b): *Atlas des Fossiles caracteristique de Madagascar* (*Ammonites*), **13** (Coniacien), i—vii, 1—88, pls. 414—454. Serv. Géol. Repub. Malag., Tananarive.

——— (1966): Les céphalopodes crétacés du basin cotier de Tarafaya. *Notes et Mém. Serv. Géol. Marac,* **175**, 1—78, pls. 1—35.

——— (1969): *Atlas des Fossiles caracteristique de Madagascar* (*Ammonites*), **15** (Campanien inferieur), i—xi, 1—216, pls. 514—606. Serv. Géol. Repub. Malag., Tananarive.

Cooper, M. R. (1978): Uppermost Cenomanian-basal Turonian ammonites from Salinas, Angola, *Ann. S. Afr. Mus.*, **75** (5), 51—152.

——— (1982): Lower Cretaceous (Middle Albian) ammonites from Dombe Grande, Angola. *Ann. S. Afr. Mus.*, **89** (5), 265—314.

Crick, G. C. (1907): Cretaceous fossils of Natal. *In* Anderson, W.: *Third and final report of the Geological Survey of Natal and Zululand,* 161—250, pls. 10—15, London.

Del Valle, R., Fourcade, N. H. and Rinaldi, C. A. (1976): Sobre la presencia de *Kitchinites darwini* (Steinmann) en el Cretâcio Superior de la Isla Vicecomodoro Marambio, Antartida. *Contribuciones Instituto Antartico Argentino,* **195**, 1—33.

Douvillé, H. (1904): *Mission stratigraphique en Perse par J. de Morgan,* **3** — Etudes géologiques, Partie 4 — Paléontologie deuxième partie, Mollusques fossiles, 191—380, pls. 25—50, Paris.

——— (1931): Contribution a la géologie de l'Angola. Les ammonites de Salinas. *Bolm Mus. Lab. Miner. Géol. Univ. Lisb.*, **1**, 17—46 (not accessible).

Forbes, E. (1846): Report on the fossil Invertebrata from southern India, collected by Mr. Kaye and Mr. Cunliffe. *Trans. Geol. Soc. London* [2], **7**, 97—174, pls. 7—19.

Grossouvre, A. de (1894): Recherches sur la craie supérieur, 2. Paléontologie — Les ammonites de la craie supérieur. *Mém. Carte Géol. Dét. France,* ii + 264 pp., 39 pls. (for 1893).

Hashimoto, W., Nagao, S. and Kanno, S. (1965): Soeushinai. *Expl. Text Geol. Map Japan, scale 1:50,000,* 1—73 (in Japanese), 75—92 (in English), quadrangle map, Geol. Surv. Hokkaido.

Hayami, I. and Maeda, H. (1983): Pioneer works on the Ammonoidea from Japan by Matajiro Yokoyama, Kotora Jimbo and Hisakatsu Yabe. *A Guide to the University Museum, the University of Tokyo,* 75—87 (in Japanese).

Hayasaka, I. (1955): On a gigantic ammonite. *Nat. Sci. & Mus.,* **22**, 36—38 (in Japanese).

Henderson R. A. (1970): Ammonoidea from the Mata Series (Santonian-Maastrichtian) of New Zealand. *Spec. Pap. Palaeont.,* **6**, 1—82, pls. 1—15.

——— (1973): Clarence and Raukumara Series (Albian — ? Santonian) Ammonoidea from New Zealand. *Jour. Royal Soc. N. Zeal.,* **3** (1), 71—123.

Henderson, R. A. and McNamara, K. J. (1985): Maastrichtian nonheteromorph ammonites from the Miria Formation, Western Australia. *Palaeontology,* **26** (1), 35—88, pls. 1—9.

Hirano, H., Matsumoto, T. and Tanabe, K. (1977): Mid-Cretaceous stratigraphy of the Oyubari area, central Hokkaido. *In* Matsumoto, T. (organ.): Mid-Cretaceous Events — Hokkaido Symposium, 1976. *Palaeont. Soc. Japan Spec. Pap.,* **21**, 1—10.

Hoepen, I. E. C. N. van (1951): A remarkable desmoceratid from the South African Albian. *Pal. Navors. Nas. Mus. Bloemfontein,* **1**, 345—349.

——— (1968): New or little known Zululand and Pondoland ammonites. *Ann. Geol. Surv. S. Afr.,* **4** (for 1965), 157—181, incl. 12 pls.

Howarth, M. K. (1965): Cretaceous ammonites and nautiloids from Angola. *Bull. Brit. Mus. (Nat. Hist.), Geol.,* **10** (10), 337—412, pls. 1—13.

——— (1966a): A mid-Turonian ammonite fauna from the Mocamedes desert; Angola. *Garcia de Orta* (Lisboa), **14** (2), 217—228, pls. 1—3.

——— (1966b): Ammonites from the Upper Cretaceous of the James Ross Island Group. *Brit. Antarct. Surv. Bull.,* **10**, 55—69, 6 figs.

Hyatt, A. (1889): Genesis of the Arietitidae. *Smithson. Contr. Knowl.,* **673**, xi+238 pp., 14 pls.

——— (1900): Cephalopoda. *In* Zittel, K. A.: Text-book of Palaeontology, 1st Engl. ed., transl. Eastman, C. R., 502—592.

Ichikawa, T. and Hayami, I. (1978): Catalogue of type and illustrated specimens in the Department of Historical Geology and Palaeontology of the University Museum, University of Tokyo. Part I. Paleozoic and Mesozoic fossils. *Univ. Mus. Univ. Tokyo Material Rept.* **2**, i—x, 1—396.

Igi, S., Tanaka, K., Hata, M. and Sato, H. (1958): Horokanai. *Expl. Text Geol. Map Japan, scale 1:50,000,* 1—55 (in Japanese), 1—9 (abstract in Engl.), quadrangle map, Geol. Surv. Japan.

Immel, H. (1979): Cenoman-Ammoniten aus den Losensteiner Schichten der Bayerischen Alpen. *In* Wiedmann, J. (ed.): *Aspekte der Kreide Europas* (IUGS. Series A, **6**), 607—644 pls. 1—4, Schweizb., Stuttgart.

Jacob, C. (1908): Etudes sur quelques ammonites du Crétacé moyen. *Mém Soc. Géol. France, Paléont.,* **15**, no. 38 (for 1907), 1—63, pls. 11—19 (6—9).

Jimbo, K. (1894): Beiträge zur Kenntniss der Fauna der Kreide-formation von Hokkaido. *Palaeont. Abhandl. N. F.,* **2** (3), 147—194 (1—48), pls. 17—25 (1—9).

Jones, D. L. (1967): Cretaceous ammonites from the lower part of the Matanuska Formation, southern Alaska. With a stratigraphic summary by A. Grantz. *U. S. Geol. Surv. Prof. Pap.* **547**, 1—49, pls. 1—10.

Kaplan, U., Keller, S. and Wiedmann, J. (1985): Ammoniten- und Inoceranen-Gliederung des norddeutschen Cenoman. *Österr. Akad. Wiss., Schriftenreihe Erdw. Komm.,* **7** (for 1984), 307—347.

Kaplan, U. and Schmid, F. (1983): Der GroBammonit *Pachydesmoceras denisonianum* (Stoliczka) und die Feinstratigraphie des hohen Ober-Cenoman im Hesseltal bei Halle in Westfalen (NW-Deutschland). *Veroff. Naturkde.-Mus. Bielefeld,* **5**, 5—20.

Kawada, M. (1929): On some new species of ammonites from the Naibuchi district, South Saghalien. *Jour. Geol. Soc. Tokyo,* **36**, 1—6, pl. 14.

Kennedy, W. J. (1971): Cenomanian ammonites from southern England. *Spec. Pap. Palaeont.,* **8**, v+133pp., 64pls.

——— and Klinger, H. C. (1978): Cretaceous fauna from Zululand and Natal, South Africa. The ammonite family Lytoceratidae Neumayr, 1875. *Ann. S. Afr. Mus.,* **74** (12), 257—333, 53 figs.

———, Wright, C. W. and Klinger, H. C. (1979): Cretaceous fauna from Zululand and Natal, South Africa. A new genus and species of tuberculate desmoceratacean ammonite from the Mzinene Formation (Albian). *Ann. S. Afr. Mus.,* **78** (4), 29—38, 4 figs.

Koenen, A. von (1898): Nachtrag zu Ueber Fossilien der unteren Kreide an Ufer des Mungo in Kamerun. *Abh. König. Ges. Wiss. Göttingen, N. F.,* **1**, 49—65, pls. 5—7.

Kossmat, F. (1897—1898): Untersuchungen über die südindische Kreideformation. II. *Beitr. Paläont. Geol. Öst.-Ung. Or.,* **11** (1) (1897), 1—46 (108—153), pls. 1—8 (12—19); III. *Ibid.* **11** (3) (1898), 89—152

(154—217), pls. 14—19 (20—25).
Kulmann, J. and Wiedmann, J. (1970): Significance of sutures in phylogeny and Ammonoidea. *Palaeont. Contr. Univ. Kansas,* **47**, 1—32.
Landois, H. (1895): Die Riesenammoniten von Seppenrade. *Jber. Westfal. Provinz-vereins f. Wissensch. u. Kunst,* 23, 1—10, pls. 1—2.
Laube, G. C. and Bruder, G. (1887): Ammoniten der böhmischen Kreide. *Palaeontogr.,* **33**, 217—239, pls. 23—29.
Leanza, A. F. (1967): Anotaciones sobre los fósiles jurasico-cretacicos de Patagonia austral (coleccion Feruglio) conservados en la Universidad de Bologna. *Act. geol. lilloana,* **11**, 121—188.
——— (1970): Ammonites nuevos o pocos conocidos del Aptiano, Albiano y Cenomaniano de los Andes australes con notas acerca de su posicion estratigrafica. *Revista Assoc. Geol. Argentina,* **25** (2), 197—261 incl. 43 figs.
Lehmann, U. (1976): *Ammoniten. Ihr Leben und ihre Umwelt,* 171pp., Enke, Stuttgart.
Macellari, C. E. (1986): Late Campanian-Maastrichtian ammonite fauna from Seymour Island (Antarctic Peninsula). *Jour. Paleont.* **60**, Suppl, to (2), *Paleont. Soc. Mem.* **18**, 1—55 incl. 41 figs.
Marcinowski, R. (1977): Giant ammonites of the subgenus *Anapuzosia* Matsumoto, 1954, from the Upper Albian of Crimea, Soviet Union, *Acta Geol. Polonica,* **27** (3). 409—416, pls. 1—2.
——— (1980): Cenomanian ammonites from German Democratic Republic, Poland, and the Soviet Union. *Acta Geol. Polonica,* **30** (3), 215—325, pls. 1—30.
Marshall, P. (1926): The Upper Cretaceous ammonites of New Zealand. *Trans. Proc. New Zeal. Inst.,* **56**, 129—210, pls. 19—47.
Matsumoto, T. (1938): A biostratigraphic study on the Cretaceous deposits of the Naibuchi Valley, South Karahuto. *Proc. Imp. Acad., Tokyo,* **14** (5), 190—194.
——— (1942—43): Fundamentals in the Cretaceous stratigraphy of Japan. Part I. *Mem. Fac. Sci. Kyushu Univ. [D] Geol.,* **1** (3), 129—280, pls. 5—20 (1942); Parts II & III. *Ibid.,* **2** (1), 97—237 (1943).
——— (ed.) (1954a): *The Cretaceous System in the Japanese Islands,* 324pp., 36pls., Japan Soc. Prom. Sci. Res., Tokyo.
——— (1954b): Family Puzosiidae from Hokkaido and Saghalien. *Mem. Fac. Sci. Kyushu Univ. [D] Geol.,* **5** (2), 69—118, pls. 9—23.
——— (1959a): Cretaceous ammonites from the upper Chitina valley, Alaska. *Mem. Fac. Sci. Kyushu Univ. [D] Geol.,* **8** (1), 49—90, pls. 12—29.
——— (1959b): Upper Cretaceous ammonites of California. Part 2. *Mem. Fac. Sci. Kyushu Univ. [D] Geol.,* Spec. Vol. **1**, 172 pp., 41 pls.
——— (ed.) (1963): *A Survey of Fossils from Japan Illustrated in Classical Monographs (Primarily a nomenclatorial revision).* Palaeont. Soc. Japan 25th Anniv. Vol. 1963, 57 p., 68 pls., Tokyo.
——— (1965): A monograph of the Collignoniceratidae from Hokkaido. Part I. *Mem. Fac. Sci. Kyushu Univ. [D] Geol.,* **16** (1), 1—80, pls. 1—18.
——— (1975): Additional acanthoceratids from Hokkaido. *Mem. Fac. Sci. Kyushu Univ. [D] Geol.,* **22** (2), 69—118, pls. 9—23.
——— (1984a): The so-called Turonian-Coniacian boundary in Japan. *Bull. Geol. Soc. Denmark,* **33**, 171—181.
——— (1984b): Ammonites from the Upper Campanian of the Teshio Mountains. *In* Matsumoto, T. and Miyauchi, T: Some ammonites from the Campanian (Upper Cretaceous) of northern Hokkaido. Part I. *Palaeont. Soc. Japan Spec. Pap.,* **27**, 1—32, pls. 1—9.
——— (1987): Note on *Pachydesmoceras,* a Cretaceous ammonite genus. *Proc. Japan Acad.,* **63** [B] (1), 5—8.
——— and Harada, M. (1964): Cretaceous stratigraphy of the Yubari dome, Hokkaido. *Mem. Fac. Sci. Kyushu Univ. [D] Geol.,* **15** (1), 79—115, pls. 9—11.
——— and Haraguchi, Y. (1978): A new texanitine ammonite from Hokkaido. *Trans. Proc. Palaeont. Soc. Japan [N. S.],* (110), 306—318, pl. 42.,
——— and Kawano, T. (1975): A find of *Pseudocalycoceras* from Hokkaido. *Trans. Proc. Palaeont. Soc. Japan [N. S.]* (97), 7—21, pl. 1.
———, Muramoto, T. and Inoma, A. (1972): Two small desmoceratid ammonites from Hokkaido. *Trans. Proc. Palaeont. Soc. Japan [N. S.]* (87), 377—394, pl. 47.
——— and Obata, I. (1955): Some Upper Cretaceous desmoceratids from Hokkaido and Saghalien. *Mem. Fac. Sci. Kyushu Univ. [D] Geol.,* **5** (3), 119—151, pls. 24—30.
——— and Okada, H. (1973): Saku Formation of the Yezo geosyncline. *Sci. Repts. Dept. Geol. Kyushu Univ.,* **11** (2), 275—309 (in Japanese with English abstract).
———, Okada, H., Hirano, H. and Tanabe, K., Okamura, M., Takayanagi, Y., Obata, I., Noda, M. and Tamura, M. (1978): Mid-Cretaceous zonation in Japan. *In* Reyment, R. A. and Thomel, G. (eds.): Mid-Cretaceous Events, Uppsala 1975—Nice 1976. *Ann. Mus. d'Hist. Nat. Nice,* **4** (for 1976), (33), 1—23.

—— and Saito, R. (1987): Little known ammonite *Grandidiericeras* from Hokkaido. *Trans. Proc. Palaeont. Soc. Japan [N. S.],* (145), 1—9, 5 figs.

—— and Toshimitsu, S. (1984): On the systematic positions of the two ammonite genera *Hourcquia* Collignon, 1965 and *Pseudobarroisiceras* Shimizu, 1932. *Mem. Fac. Sci., Kyushu Univ. [D] Geol.,* 25 (2), 229—246, pls. 32—35.

—— and —— (1987): Dimorphism in *Hauericeras* (Cretaceous ammonite). *Abstract Palaeont. Soc. Japan Ann. Meet.* 1987.

Matsuno, K., Tanaka, K., Mizuno, A. and Ishida, M. (1964): Iwamizawa. *Expl. Text Geol. Map. Japan, scale 1:50,000,* 1—168 (in Japanese), 1—11 (abstract in English), quadrangle map, Geol. Surv. Japan.

Mikailova, I. A. (1983): *Systematics and Phylogeny of the Cretaceous Ammonoidea,* 280 pp., Acad. Sci. USSR. (in Russian).

Miller, A. K. and Youngquist, W. (1946): A giant ammonite from the Cretaceous of Montana. *Jour. Palaeont.,* **20,** 479—484, pls. 73—75.

Murphy, M. A. and Rodda, P. U. (1960): Mollusca of the Cretaceous Bald Hills Formation of California. *Jour. Paleont.,* **34** (5), 835—858, pls. 101—107.

Nagao, S., Osanai, H. and Sako, S. (1954): Oyubari. Expl. Text Geol. Map Japan, Scale 1:50,000. 1—110 (in Japanese), 111—121 (résumé in English), quadrangle map.

Nowak, K. (1913): Untersuchungen über die Cephalopoden der oberen Kreide in Polen. III Teil. *Bull. Acad. Sci. Cracovie, Cl. Sci. Math. Nat. [B],* **1913,** 335—415, pls. 40—44.

Nullo, G. B. de, Nullo, F. and Proserpio, C. (1980): Santoniano-Campaniano estatigrafia y contenido ammontifero Cuenca austral. *Assoc. Geol. Argentina Revista,* **35** (4), 467—493, pls. 1—5.

Obata, I. (1967): Lower Cretaceous ammonites from the Miyako Group. Part I. *Valdedorsella* from the Miyako Group. *Trans. Proc. Palaeont. Soc. Japan [N. S.],* (66), 63—72, pl. 8.

Orbigny, A. d' (1840—1842): *Paléontologie francaise. Terrains crétacés* 1, Céphalopodes, 1—120 (1840); 121—430 (1841); 431—662 (1842), 151 pls., Paris.

Parona, C. F. and Bonarelli, E. G. (1897): Fossili Albiani d'Escragnolles, del Nizzardo e della Liguria occidentale. *Palaeont. Ital.,* **2,** 53—112, pls. 10—14.

Phillips. D. (1977): *Catalogue of the Type and Figured Specimens of the Mezozoic Ammonoidea in the British Museum (Natural History).* i—iii, 1—220, Brit. Mus. (Nat. Hist.), London.

Popovici-Hatzeg, V. (1899): Contribution a l'etude de la faune du Crétacé supérieur de Roumanie Environs de Campulung et de Sinaia. *Mém. Soc. Géol. France. Paléont.,* **8** (3), Mém. 20, 1—20, pls. 14—15.

Renz, O. (1972): Die Gattungen *Puzosia* Bayle, *Bhimaites* Matsumoto und *Desmoceras* Zittel (Ammonoidea) im oberen Albien Venezuelas. *Eclog. Geol. Helv.,* **65** (3), 701—723, pls. 1—10.

——(1976): Ein grosser *Pachydesmoceras* (Ammonoidea) aus den Unteren Cénomanien des Schweizer Juras. *Eclog. Geol. Helv.,* **69** (3), 753—763, pl. 1.

——(1982): *The Cretaceous Ammonites of Venezuela,* 132 pp., 40 pls., Birkhauser, Basel.

Reyment, R. A. (1955): The Cretaceous Ammonoidea of southern Nigeria and the southern Cameroons. *Bull. Geol. Surv. Nigeria,* **25,** 1—112, pls. 1—25.

Riccardi, A. C. (1980): Nuevos ammonoides del Cretacico superior de Antartida. *Ameghiniana,* **17** (4), 323—333.

Roman, F. and Mazeran, P. (1913): Monographie paléontologique de la faune du Turonien du bassin d'Uchaux et de ses dépendances, *Arch. Mus. Hist. Nat. Lyon,* **12,** 1—137, pls. 1—11.

Sastry, M. V. A., Rao, B. B. J. and Mamgain, V. D. (1968): Biostratigraphic zonation of the Upper Cretaceous formations of Trichinopoly district, South India. *In* Cretaceous-Tertiary Formations of South India. *Geol. Soc. India. Mem.,* **2,** 10—17, pls. 1—4.

——, —— and —— (1969): A giant ammonite from the Trichinopoly Cretaceous, South India. *Records Geol. Surv. India,* **97** (2), 103—107, pls. 15—17.

Schlotheim, E. F. Von (1820): *Die Petrefaktenkünde auf ihrem jetzigen Standpunkt durch die Beschreibung einer Shammlung* .... 1 xii + 437 pp., Gotha (inaccessible).

Schindewolf, O. H. (1966): Studien zur Stammesgeschichte der Ammoniten. Lief. V. *Akad. Wiss. Lit., Abh. Math.-Naturw. Klasse,* Jahrgang **1966** (3), 327—454 (511—640).

Scholz, G. (1979): Die Ammoniten des Vracon (Oberalb *dispar* Zone) des Bakony-Gebirges (Westungarn) und eine revision der wichtigsten Vracon-arten des Westmediterranen faunenprovinz. *Palaeontogr.,* **A165,** 1—136, pls. 1—30.

Sharpe, D. (1853—1857): Description of the fossil remains of Mollusca found in the Chalk of England. I Cephalopoda. *Palaeontogr. Soc. Monogr.,* 68 pp., 27 pls.: 1—26, pls. 1—10 (1853); 27—36, pls. 11—16 (1855) 37—68, pls. 17—27 (1857).

Shimizu, I., Tanaka, K. and Imai, I. (1953): Kami-Ashibetsu. Expl. *Text Geol. Map Japan, scale 1:50,000,* 1—78 (in Japanese), 1—21 (résumé in English), folded tables 1—2, folded figs. 1—6, route maps 1—8, quadrangle

map, Geol. Surv. Japan.
Shimizu, S. (1935): The Upper Cretaceous cephalopods of Japan. Part I. *Jour. Shanghai Sci. Inst.* [2], **2**, 159—226.
Simioescu, I. (1944): Citiva amoniti din Cretaceul superior. *An. Acad. Rom., Mem. sect. st. [3],* **19**, mem. 2, 1—15, pl. 1—2 (inaccessible).
Sowerby, J. de C. (1826—29): *The Mineral Conchology of Great Britain* (part), **6**, pls. 504—544 (1826), pls. 545—580 (1827); pls. 581—597 (1828); pls. 598—609 (1829).
Spath, L. F. (1922): On the Senonian ammonite fauna of Pondoland. *Tans. Roy. Soc. S. Afr.,* **10**, 113—147, pls. 5—9.
—— (1923): A monograph of the Ammonoidea of the Gault. Part I. *Monogr. Palaeontogr. Soc.* London, for 1921, 1—72, pls. 1—4.
—— (1925): Sur quelques ammonites du Gault, nommees par R. Reynes. *Ann. Mus. Hist. Nat. Marseille,* **20**, 1—15, pl. 4.
Steinmann, G. (1895): Die Cephalopoden der Quiriquina-Schichten. *In* Steinmann, G., Deecke, W. and Möricke, W.: Das Alter und die Fauna der Quiriquina-Schichten in Chile. *Neues Jahrb. Min. Geol.-Palaönt., Beil. Bd.,* **10**, 64—94, pls. 4—6.
Stoliczka, F. (1863—1866): The fossil Cephalopoda of the Cretaceous rocks of southern India. Ammonoidea, with revision of the Nautilidae. *Mem. Geol. Surv. India, Palaeont. Indica* [3], 4—56, pls. 26—31 (1863); 57—106, pls. 32—54 (1864); 107—154, pls. 55—80 (1865); 155—216, pls. 81—94 (1866).
Summesberger, H. (1979): Eine obersantone Ammoniten fauna aus dem Becken von Gosau (Oberösterreich). *Ann. Naturhistor. Mus. Wien,* **82**, 109—176, pls. 1—15.
Szász, L. (1983): Contribution à létude des ammonites Cénomaniennes de la Roumanie. *Inst. Géol. Géophy. Mém. (Bucarest),* **31**, 237—260, pls. 1—20.
Tanabe, K., Hirano, H., Matsumoto, T. and Miyata, Y. (1977): Stratigraphy of the Upper Cretaceous deposits in the Obira area, northwestern Hokkaido. *Sci. Rept. Dept. Geol. Kyushu Univ.,* **12** (3), 181—202 (in Japanese with English abstract).
Tanaka, K. (1963): A study of the Cretaceous sedimentation in Hokkaido, Japan. *Rept. Geol. Surv. Japan,* **197**, 122 pp, 2 maps, 3 pls.
Toshimitsu, S. (1985): Biostratigraphy and depositional facies of the Cretaceous in the upper reaches of the Haboro River, Hokkaido. *Jour. Geol. Soc. Japan,* **91** (9), 599—618 (in Japanese with English abstract).
Tsushima, K., Tanaka, K., Matsuno, H. and Yamaguchi, S. (1958): Tappu. *Expl. Text Geol. Map Japan, scale 1:50,000,* 1—66 (in Japanese), 1—8 (abstract in English), quadrangle map, Geol. Surv. Japan.
Ueda, Y., Matsumoto, T. and Akatsu, K. (1962): The Cretaceous deposits in the Chikubetsu area, Hokkaido. *Sci. Rept. Dept. Geol. Kyushu Univ.,* **6** (1), 15—32, folded map (in Japanese with English abstract).
Venzo, S. (1936): Cephalopodi del Cretacea medio-superiore dello Zululand. *Palaeont. Ital.,* **36**, 59—133, pls. 5—12.
Verechagin, V. N., Kinasov, V. P., Parakachov, K. V. and Terexova, G. P. (1965): *Field Atlas of the Cretaceous Fauna from Northeast, USSR,* 216 pp. incl. 74 pls. Natn. Ind. Geol. Comm., Magadan (in Russian).
Wiedmann, J. and Boess, J. (1984): Ammonitenfunde aus der Biskaya-Syncline (Nordspanien) — Kreideglieder ung und Alter des Kreide-Vulkanismus. *Eclogae Geol. Helv.,* **77** (3), 483—510.
—— and Dieni, I. (1968): Die Kreide Sardiniens und ihre Cephalopoden. *Palaeont. Ital.,* **64**, 1—171, pls. 1—18.
Wright, C. W. (1955): Notes on Cretaceous ammonites. II. The phylogeny of the Desmoceratac eae and the Hoplitaceae. *Ann. Mag. Nt. Hist.* [12], **8**, 561—575.
——(1979): The ammonites of the English Chalk Rock (Upper Turonian). *Bull. Brit. Mus. (Nat. Hist.) [Geol.]* **31** (4), 281—332 (incl. 7 pls.).
——(1981): Cretaceous Ammonoidea. *In* House, M. R. and Senior, J. (eds.): *The Ammonoidea.* The Systematics Assoc. Spec. Vol. no. 18, 157—174.
——and Kennedy W. J. (1981): The Ammonoidea of the Plenus Marls and the Middle Chalk. *Monogr. Palaeontogra. Soc.* London, 1—148, pls. 1—32 (Publ. no. 560, part of vol. 134 for 1980).
——and —— (1984): The Ammonoidea of the Lower Chalk. Part I. *Monogr. Palaeontogr. Soc.* London, 1—126, pls. 1—40 (Publ. no. 567, part of vol. 137 for 1983).
—— and Wright, E. V. (1951): A survey of the fossil Cephalopoda of the Chalk of Great Britain. *Monogr. Palaeontogr. Soc. London,* 1950, 1—40.
Yabe, H. (1914): Ein neuer Ammonitenfund aus der Trigonia Sandstein Gruppe von Provinz Tosa. *Sci. Rept. Tohoku Imp. Univ.* [2], **1** (5), 71—74, pl. 12.
——(1972): Cretaceous stratigraphy of the Japanese Islands. *Sci. Rept. Tohoku Imp. Univ.* [2], **11** (1), 27—100, pls. 3—9
Yokoyama, M. (1890): Versteinerung aus der japanische Kreide. *Palaeontogr.* **36**, 159—202, pls. 18—25.

Young, K. (1963): Upper Cretaceous ammonites from the Gulf Coast of the United States. *Univ. Texas Publ.*, **6304**, 1—373 (incl. 82 pls.)

Zimmermann, E. (1912): *Puzosia rauffi* n. sp. und *Puzosia denisoniana* Stol. in der Oberen Kreide Norddeutschlands und die Loben der bisher bekannten *Puzosia*-Arten. *Jahrb. K. Preuss. Geol. Landes.*, **33**, 533—556, pls. 25—26.

Postscript

Manuscript of this monograph was submitted to the Editor of the Palaeontological Society of Japan Special Papers on 30th April 1987, and after the examination by two anonymous referees, an application was made from the Society to the Ministry of Education, Science and Culture (*Monbusho*) for a financial aid to publish the complete manuscript. Thanks to the authorities concerned the grant was informed to the Society on August 5, 1988. During these 15 months several papers relevant to this work have arrived at my address in Fukuoka. For instance, "A revision of the Puzosiinae (Cretaceous Ammonites) of the Cambridge Greensand" by M. R. Cooper and W. J. Kennedy, 1987 (*N. Jb. Geol. Paläont. Abh.*, vol. 174, p. 105—121) is one of the most important papers. It generally conforms with what I have written in this monograph, although a discussion would be required as to minor details. As a rule, a great alternation in pages and figures should be avoided and the designated deadline should be strictly kept in publishing the granted monograph. Therefore, I apologize that I do not give any alteration or addition other than this postscript to the submitted manuscript.

August 6, 1988 T. M.

Index of Genera and Species

Names of genera, subgenera, species and subspecies are indicated in alphabetic order, with page(s) where they are described (by bold) or mentioned. F. means figure(s). New taxa are boldfaced.

R

S

T

U

V

Y

W

Number 25 (Isseud November 15, 1982) Multidisciplinary Research in the Upper Cretaceous of the Monobe Area, Shikoku .....Compiled by Tatsuro MATSUMOTO and Masayuki TASHIRO

Number 26 (Issued December 24, 1984) Permian Trilobites of Japan in Comparison with Asian, Pacific and Other Fanuas .....Teiichi KOBAYASHI and Takashi HAMADA

Number 27 (Issued November 24, 1984) Some Ammonites from the Campanian (Upper Cretaceous) of Northern Hokkaido .....
..... Part I and III by T. MATSUMOTO, Part II by T. MATSUMOTO and T. MIYAUCHI

Number 28 (Issued November 24, 1985) Bibliography of Palaeontology in Japan 1976-1980.....
..... Tomoki KASE and Kazuo ASAMA

Number 29 (Issued November 25, 1986) Japanese Cenozoic Molluscs—Their Origin and Migration
.....Edited by Tamio KOTAKA

Palaeontological Society of Japan, Special Papers No. 30

A Monograph of the Puzosiidae (Ammonoidea) from the Cretaceous of Hokkaido

1988年12月10日印刷
1988年12月15日発行

定価 6,300円

編集者 柳田寿一
発行者 日本古生物学会
東京都文京区弥生2-4-16
日本学会事務センター内
印刷者 学術図書印刷株式会社
富田潔
東京都練馬区豊玉北2ノ13