A Monograph of the Collignoniceratidae from Hokkaido Part I : Studies of the Cretaceous Ammonites from Hokkaido and Saghalien-XIV

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A Monograph of the Collignoniceratidae from Hokkaido

Part I

(Studies of the Cretaceous Ammonites from Hokkaido and Saghalien—XIV)

By

Tatsuro MATSUMOTO

Abstract

The collignoniceratid ammonites from the Cretaceous of Hokkaido are monographed. Part I contains the introductory remarks and the systematic descriptions of the subfamily Collignoniceratinae, with some revision of genera. One species of *Collignoniceras*, two new species of *Prionocyclus*, one new species and two others of *Prionocycloceras*, one new species of *Subprionotropis*, four species of *Subprionocyclus*, one new species probably referred to *Niceforoceras* and a new species under a new genus are described. *Reesidites minimus* is clearly redescribed. In comparison with the species from Hokkaido remarks are given on some species occurring outside Japan.

Contents

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Introduction

The family Collignoniceratidae is taken here to include the subfamilies Collignoniceratinae, Peroniceratinae, Texanitinae, Barroisiceratinae and Lenticeratinae. As I have already mentioned (MATSUMOTO, 1959a, p. 62), some representatives of the Collignoniceratids occur in the Upper Cretaceous sequence of Japan and adjacent areas and are very useful for interregional correlation. This paper contains the palaeontological descriptions of them.

The following is a concise historical review of previous relevant work at home and abroad.

MEEK (1876) seems to have been the first to recognize the characteristics of the group, introducing *Prionocyclus*, *Prionotropis* and *Mortoniceras*. DE GROSSOUVRE (1894) subsequently established *Barroisiceras* [=*Barroisia* GROSSOUVRE, *non* MUNIER-CHALMAS, 1882], *Gauthiericeras* and *Peroniceras*, but he referred them to his Acanthoceratids, which are almost as comprehensive as the Acanthocerataceae in present usage. So ZITTEL (1895) introduced the family Prionotropidae for *Prionotropis* and its allies, in which a homoeomorphic hoplitid genus *Schloenbachia* was still included. On describing several interesting species from Colombia, GERHARDT (1897) established *Lenticeras*. HYATT (1900, 1903) attempted to split certain broad and polyphyletic groups and proposed many new families and genera, including Peroniceratidae, Lenticeratidae and Eulophoceratidae.

For about two decades no fundamental alteration was made in the classification of the group under consideration, although our knowledge was enriched by descriptions of many species from various parts of the world, as exemplified by the papers of KOSSMAT (1895), ANDERSON (1902), SOLGER (1904), LASSWITZ (1904), WOODS (1906), CRICK (1907), PERVINQUIÈRE (1907, 1910), BRÜGGEN (1910), LÜTHY (1918), BURCKHARDT (1919-21), TAUBENHAUS (1920), DESIO (1920) and VAN HOEPEN (1921).

SPATH (1921) started another epoch in refining the taxonomy, introducing *Pseudoschloenbachia*, *Diaziceras* and *Submortoniceras*. At that date the generic name *Mortoniceras* was still used for the Senonian species. With the aid of ADKINS' (1928) work, the type-species of *Mortoniceras* was identified as an Albian species by SPATH (1932), who proposed *Texanites* for the Senonian species generally referred to *Mortoniceras*; he referred *Texanites* to the Peroniceratidae. Prior to this SPATH (1925) had clearly distinguished Schloenbachiidae from Prionotropidae and then (1926) established *Neocardioceras* which he regarded as an early genus of Prionotropidae. SPATH (1926), furthermore, introduced *Prionocycloceras* for a species of GERHARDT from Colombia, while TOKUNAGA and SHIMIZU (1926) erected *Yabeiceras* for certain interesting species from Japan. SHIMIZU (1932) subsequently proposed *Subprionocyclus* and *Pseudobarroisiceras*, which for some reason did not receive much attention for more than two decades. Meanwhile REESIDE (1932) revised *Barroisiceras*, proposing *Texasia*, *Alsta-*

denites, *Forresteria*, *Harleites* and *Solgerites* as subgenera. WARREN and STELCK (1940) proposed *Selwynoceras* for a Lower Turonian prionotropid from Canada which actually has a world significance.

After an apparent pause of academic work during World War II, came another epoch of active research. HAAS (1946) studied variation in and ontogeny of *Prionotropis woollgari* and *Prionocyclus wyomingensis*. The generic name *Prionotropis* MEEK, 1876 was shown to be preoccupied and was replaced by *Collignoniceras* BREISTROFFER, 1947; consequently Prionotropidae was replaced by Collignoniceratidae WRIGHT and WRIGHT, 1951. BREISTROFFER (1947), furthermore, established *Germariceras*. Outstanding contributions have been made by two other French palaeontologists, Vicomtesse É. BASSE de Ménorval and Gènèral M. COLLIGNON. On the basis of Madagascar material BASSE (1947) exhaustively studied *Barroisiceras* and its allies, to which *Reesideoceras*, *Zumpangoceras* and *Piveteauceras* were added as new subgenera. In another paper on Coniacian ammonites from Madagascar BASSE (1946) established *Subbarroisiceras* and *Eboroceras* and also in two other papars on those from Colombia she (BASSE, 1948, 1950) erected *Niceforoceras*, *Donjuaniceras* and *Subprionotropis*. Subsequently, however, *Piveteauceras* BASSE, 1947 and *Donjuaniceras* BASSE, 1950 have proved to be synonyms of *Solgerites* REESIDE, 1932 and *Prionocycloceras* SPATH, 1926 respectively (see REYMENT, 1954 and WRIGHT, 1957 in MOORE [Ed.]). COLLIGNON (1948) published a magnificent monograph of the Texanitidae from Madagascar, with comprehensive reviews on the group, establishing *Paratexanites*, *Parabevahites*, *Bevahites*, *Menabites*, *M.* (*Bererella*), *M.* (*Australiella*) and *M.* (*Delawarella*), in addition to describing species of *Texanites* and *Submortoniceras*. In an attempt to present a scheme of classification of the Cretaceous ammonites WRIGHT (1952) included COLLIGNON's Texanitidae in Peroniceratidae. The Peroniceratidae in this sense were discussed by MATSUMOTO (1955), who proposed *Protexanites* as an important member in the evolution of the group. WRIGHT and MATSUMOTO (1954) revised *Subprionocyclus* SHIMIZU, 1932 and established *Reesidites* as one of its derivatives. They showed the importance of *Subprionocyclus* in that it gave rise to various branches at subfamily level. This resulted in a revision by WRIGHT (1957) of his earlier (1952) classification; with this later scheme I am essentially in agreement. Similarly REYMENT (1954, 1955, 1956) removed Barroisiceratinae from Tissotiidae to Collignoniceratidae, because he found that certain species of *Subprionocyclus* are directly transitional to typical *Barroisiceras*. As regards Lenticeratinae, however, he provisionally referred it to Tissotiidae along with Coilopoceratinae, but he mentioned as another alternative that it could be connected with Collignoniceratidae. On the basis of BASSE's (1947) work REYMENT (1954, 1955) further refined Barroisiceratinae, describing species from Nigeria and Cameroons. In another paper (REYMENT, 1957) he established *Reginaites* as a subgenus of *Peroniceras*. REYMENT (1958a), furthermore, described several species from Colombia, including an example of *Reesidites*, and revised (REYMENT, 1958b, c) some of REDTENBACHER's (1873) and SOLGER's (1940) ammonites. VAN HOEPEN (1955) added more species of *Peroniceras* and *Gauthiericeras* from Zululand. His *Collignoniceras* is a homonym of *Collignoniceras* BREISTROFFER, 1947, and can be, in my opinion, included in *Forresteria*. In a paper on the Upper

Cretaceous of Spain and Portugal WIEDMANN (1959) proposed *Ciryella* as a transitional subgenus of *Gauthiericeras* between *Gauthiericeras* (*s. s.*) and *Peroniceras*. In the United States COBBAN and REESIDE (1952) and COBBAN (1953) made clear the zonal succession of Collignoniceratid species in the Turonian sequence of the Western Interior province. ANDERSON (1958) and then MATSUMOTO (1959-60) described some species from the West Coast, of value in correlation. *Oregoniceras* ANDERSON, 1958 has proved to be a synonym of *Subprionocyclus* SHIMIZU, 1932 as does *Ledoceras* BASSE, 1962. Recently YOUNG (1963) published an outstanding work on the stratigraphic succession and palaeontology of the Upper Cretaceous ammonites from the Gulf Coast, in which species of Peroniceratinae and Texanitinae occupy an important part. He attempted to modify to some extent COLLIGNON's scheme of classification, with proper evaluation of *Australiella* and introduction of *Defordiceras*. The province occupying western Texas, New Mexico and northeastern Chihauhua, Mexico, is in my opinion, important for unraveling interregional relationships of the faunae. POWELL (1963a, b) commenced a study of the ammonites from this province which include some collignoniceratid species. Lastly FAVRE-TAXY (1963) treated several species of the Collignoniceratidae in her study of the Coniacian and Santonian faunae of Provence, southeast France, another interregionally important area.

To sum up our knowledge of the Collignoniceratidae has advanced on the basis of intensive studies of faunas in various parts of the world by many authors. I endeavour in this paper to present what kinds of Collignoniceratidae are found in Japan, how they occur and how they are related to what known in overseas areas.

Turning back to the study of the species from Japan some more details should be added as a historical background. The oldest description of a Japanese example of the group under consideration is that of YABE (1902) on a species from Amakusa, western Kyushu. This has recently been revised by MATSUMOTO and UEDA (1962), who have added descriptions of three more species of Texanitinae from the Senonian Himenoura Group in Kyushu. YABE (1909) listed species of Collignoniceratidae [as Prionotropidae] from Hokkaido but had left them undescribed until YABE and SHIMIZU (1925) monographed a part of the family. SHIMIZU (1934, 1935) likewise mentioned fairly numerous species in his preliminary notes on the Upper Cretaceous Cephalopoda from Japan, including those from South Saghalien at that date, but the notes are mostly too brief to satisfy nomenclatorial requirements. Prior to this SHIMIZU (1932) established *Pseudobarroisiceras* for a species from Hokkaido and *Subprionocyclus* without showing Japanese examples. At a still earlier date TOKUNAGA and SHIMIZU (1925) established *Yabeiceras*, with descriptions of three species from the Senonian Futaba beds in northeast Honshu. Immediately after that date SHIMIZU (1926) reported an example of *Yabeiceras* from Hokkaido. KAWADA (1929) described a species of "*Mortoniceras*" [=*Texanites*] from South Saghalien.

More than ten years elapsed without notable work on Collignoniceratids from Japan. COLLIGNON (1948) gave comments on the texanitine species from Japan, as an appendix to his monograph of Menabe, Madagascar. *Barroisiceras minimum* (YABE MS.) was validated when HAYASAKA and FUKADA (1951) described in detail its ontogeny. For this species *Reesidites* was proposed by WRIGHT and MATSUMOTO (1954), who also discussed its relation with *Subprionocyclus* as amended by themselves. Subsequently MATSUMOTO (1955) discussed the evolution of the Texanitinae [included in Peroniceratidae (*s. l.*)], establishing *Protexanites* to which certain Japanese species are referred in addition to the type-species from France. Recently an example of *Bevahites* was reported from the basal part of the Izumi Group in Shikoku (MATSUMOTO and OBATA, 1963).

To sum up, the studies of the Collignoniceratidae from Japan have been rather fragmentary. This is primarily due to the generally rare occurrence of the group in this country. Now, owing to laborious efforts for many years, we are in a position to describe more than 40 species belonging to 27 genera and subgenera. In this part the species belonging to the subfamily Collignoniceratinae are described.

The material for the present study came from various sources. Geographically the localities of the described specimens are mostly in various areas in Hokkaido (Fig. 1). A few specimens from the Naibuchi valley, an area in South Saghalien [Sakhalin], are also included. To make clear the systematic positions of the species from Hokkaido and Sakhalien, I studied available specimens from North America, England and other oversea areas.

Of various areas in Hokkaido, the Ikushmbets area, comprising the valleys of the Ikushumbets and its tributaties, is the most important in that comparatively numerous specimens have been obtained there in successive sequences. The stratigraphic profiles and locality maps of this area are inserted in this paper (Figs. 2-5). In the field work for collecting fossils from this area Mr. Tatsuo MURAMOTO and his son, Mr. Kikuwo MURAMOTO, have laboriously assisted me. Mr. M. KIKUCHI, a teacher, and many school-boys of the Mikasa High School have also contributed to the collection. Dr. Nobukazu KAMBE, Dr. Keisaku TANAKA and Mr. Tamotsu OMORI have kindly supplied me with some collignoniceratid specimens which they obtained during their geological survey of the Ikushumbets and adjacent areas.

The Collignoniceratid specimens have been found also from the areas other than the Ikushumbets area by several persons including myself. The areas concerned are as follows, with references of stratigarphic papers in parentheses:

Abeshinai-Saku area or Mid-valley of the Teshio, Teshio province, northwest Hokkaido (MATSUMOTO, 1942)

Chikubets-Haboro area, Teshio province (UEDA, AKATSU and MATSUMOTO, 1962; TANAKA *in* MATSUNO and KINO, 1960; TANAKA *in* YAMAGUCHI and MATSUNO, 1963; W. HASHIMOTO *et al.*, unpublished)

Obirashibets area [Tappu and Horokanai quadrangles], Teshio province (TANAKA, 1962)

Bibai area, northern Ishikari coal-field and the upper reaches of the Ashibets, Ishikari province, central Hokkaido (TANAKA *in* SHIMIZU *et al.*, 1952)

Yubari dome [Hatonosu Hills, near Yubari], Ishikari province, central Hokkaido (MATSUMOTO and HARADA, 1964)

Shuyubari valley, Ishikari province (MATSUMOTO, 1942)

Hobetsu area, Iburi province, south central Hokkaido (personal information of stratigraphy from W. HASHIMOTO, not yet published)

Urakawa area, Hidaka province, southern Hokkaido (MATSUMOTO, 1942)

The authors of the stratigraphic papers indicated in parentheses have generously

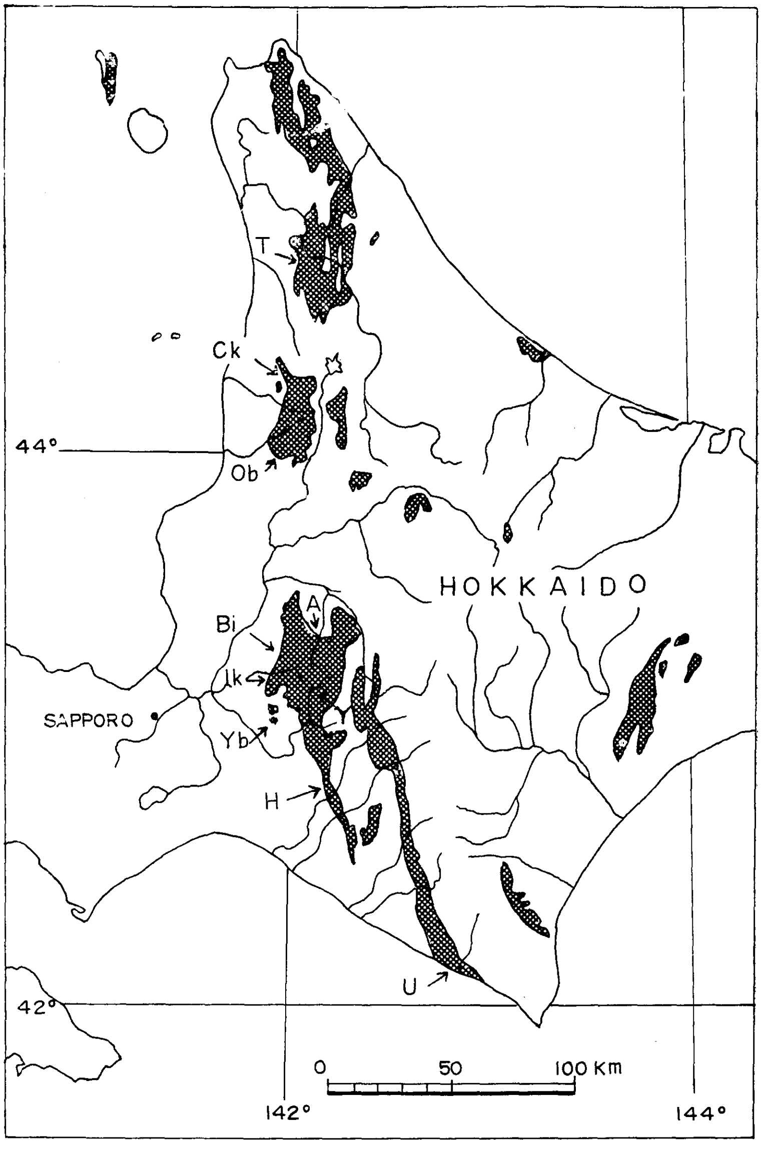

Fig. 1. Map of the main part of Hokkaido, showing Cretaceous outcrops with hatching. The areas from which the collignoniceratid ammonites have been obtained are indicated by the following abbreviations from north to south, T: Mid-valley of the Teshio or the Abeshinai-Saku area; Ch: Chikubets-Haboro area; Ob: Obirashibets area; A: Upper reaches of the Ashibets; Bi: Bibai area; Ik: Ikushumbets valley; Y: Shuyubari valley; Yb: Yubari dome; H: Hobetsu area; U: Urakawa area.

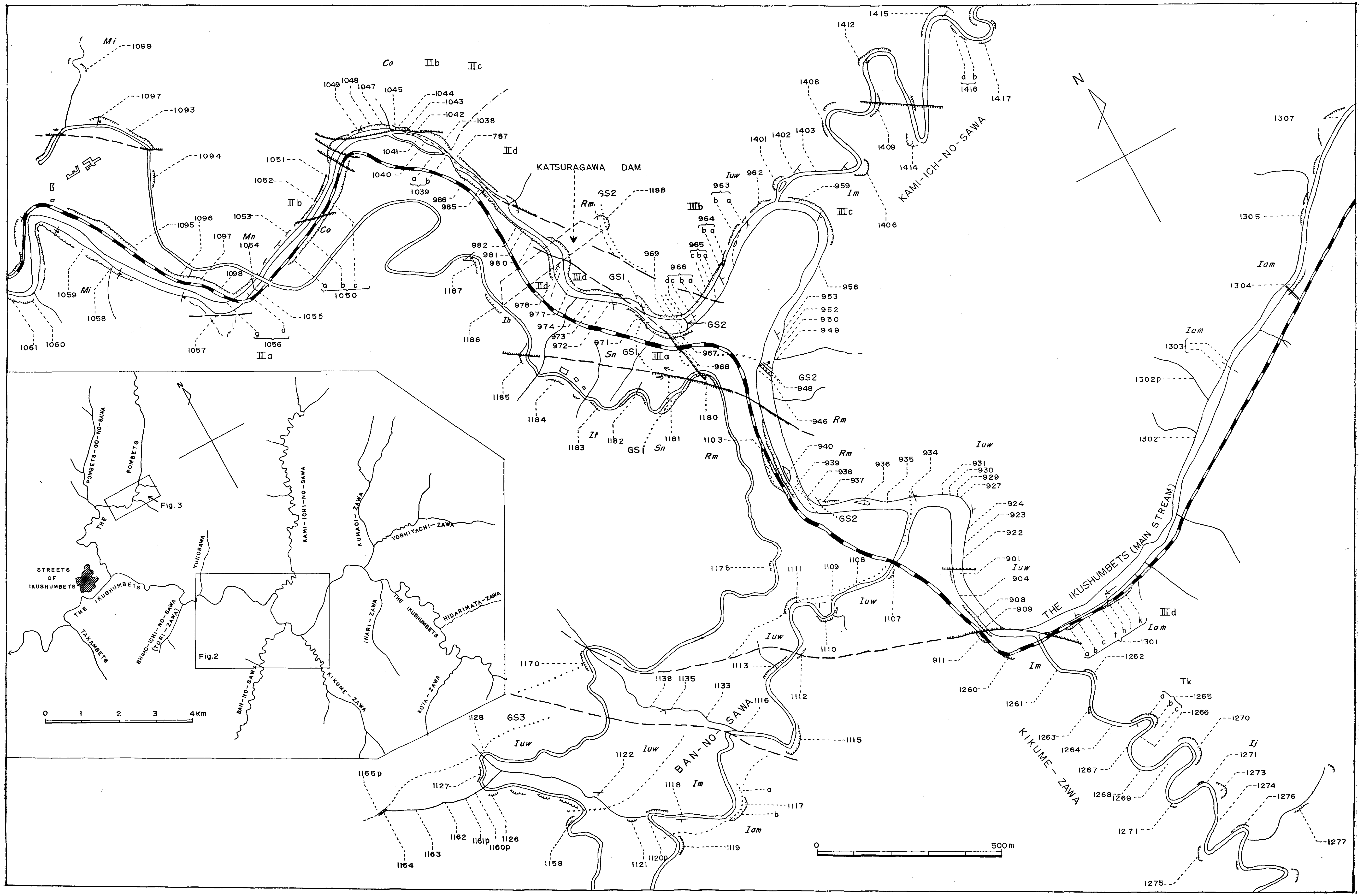

Fig. 2. Route Map along the Ikushumbets and its tributaries. All the locality numbers should have the prefix Ik. Fossil localities before and after the construction of the Katsuragawa dam are indicated. The forestry railroad along the main stream of the Ikushumbets has been abandoned since the dam was completed. See Fig. 4 for the abbreviations of the stratigraphic subdivisions and the zones. Inset is the map of the drainage system of the Ikushumbets at the left corner, indicating the location of Figs. 2 and 3. (Read 987 for 787.)

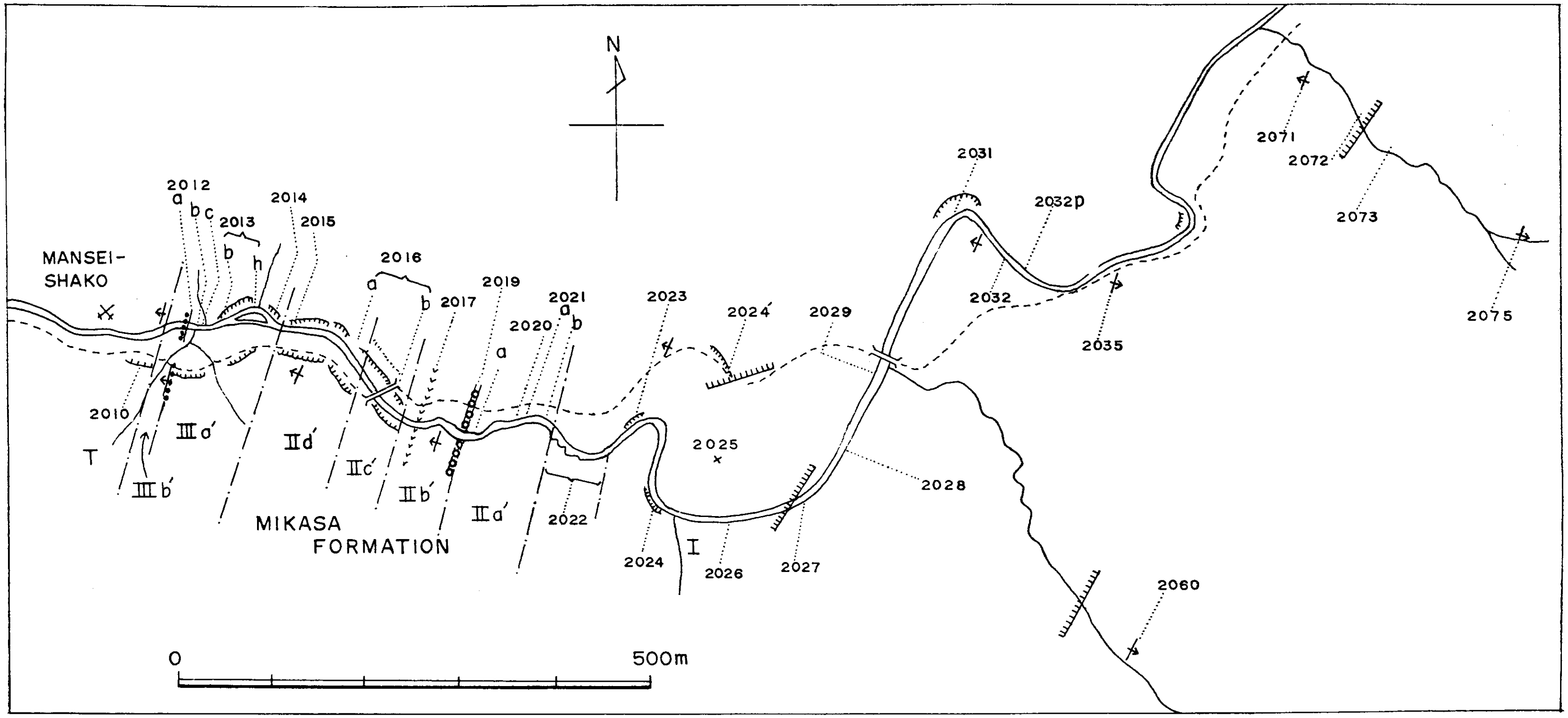

Fig. 3. Route map along the Pombets, a tributary of the Ikushumbets. All the fossil localities should have the prefix Ik. For the abbreviations of the stratigraphic subdivisions (e. g. IIa′, IIb′, etc.) see Fig. 5.

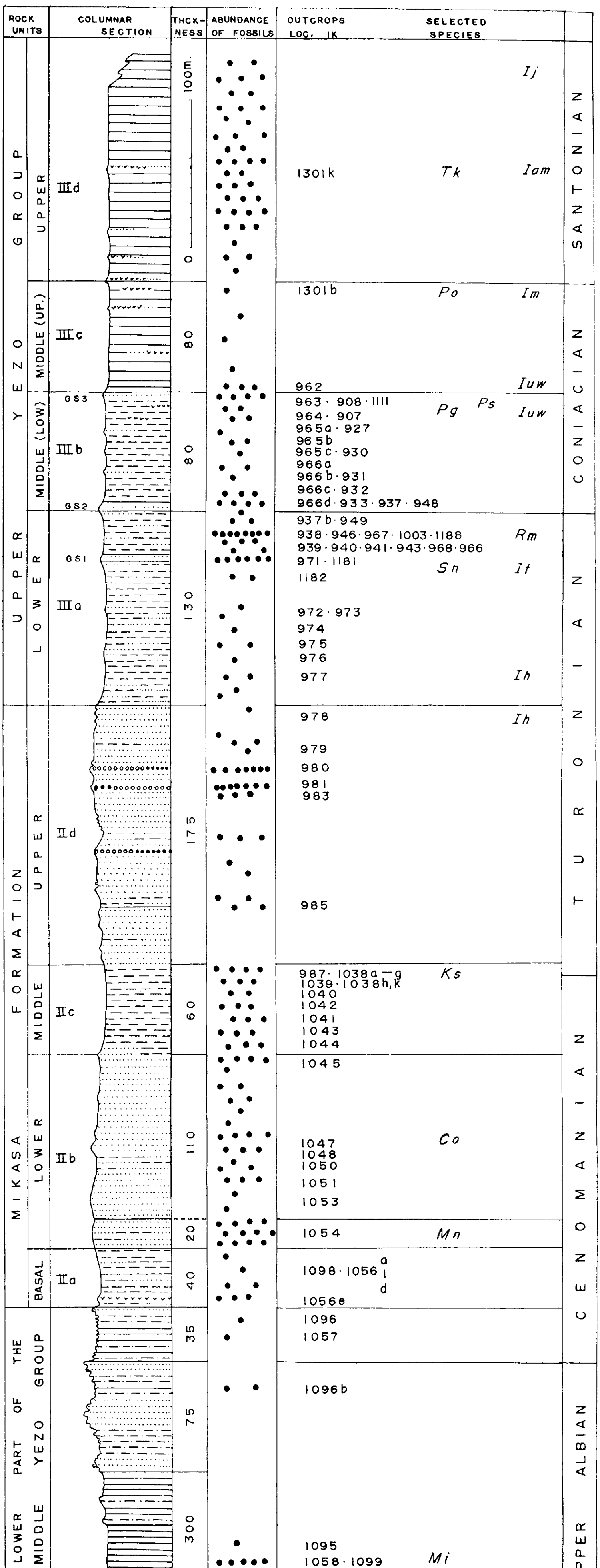

Fig. 4. Columnar section showing the stratigraphic sequence of the Cretaceous deposits on the eastern wing of the Ikushumbets anticline exposed along the main stream of the Ikushumbets. The abbreviations for the selected species of ammonites in ascending order are *Mi*: *Mortoniceras* (*Cantabrigites*) *imaii*, *Mn*: *Mantelliceras* n. sp., *Co*: *Calycoceras orientale*, *Ks*: *Kanabiceras septemseriatum*, *Sn*: *Subprionocyclus normalis*, *Rm*: *Reesidites minimus*, *Pg*: *Prionocycloceras* aff. *guayabanum*, *Ps*: *Prionocycloceras sigmoidale*, *Po*: *Paratexanites orientale*, *Tk*: *Texanites kawasakii*. Those for the zones of *Inoceramus* species are *Ih*: *Inoceramus hobetsensis*, *It*: *I. teshioensis*, *Iuw*: *I. uwajimensis*, *Im*: *I. mihoensis*, *Iam*: *I. amakusensis*, *Ij*: *I. japonicus*. See Fig. 2 for the fossil localities and Fig. 5 for the lithologic symbols.

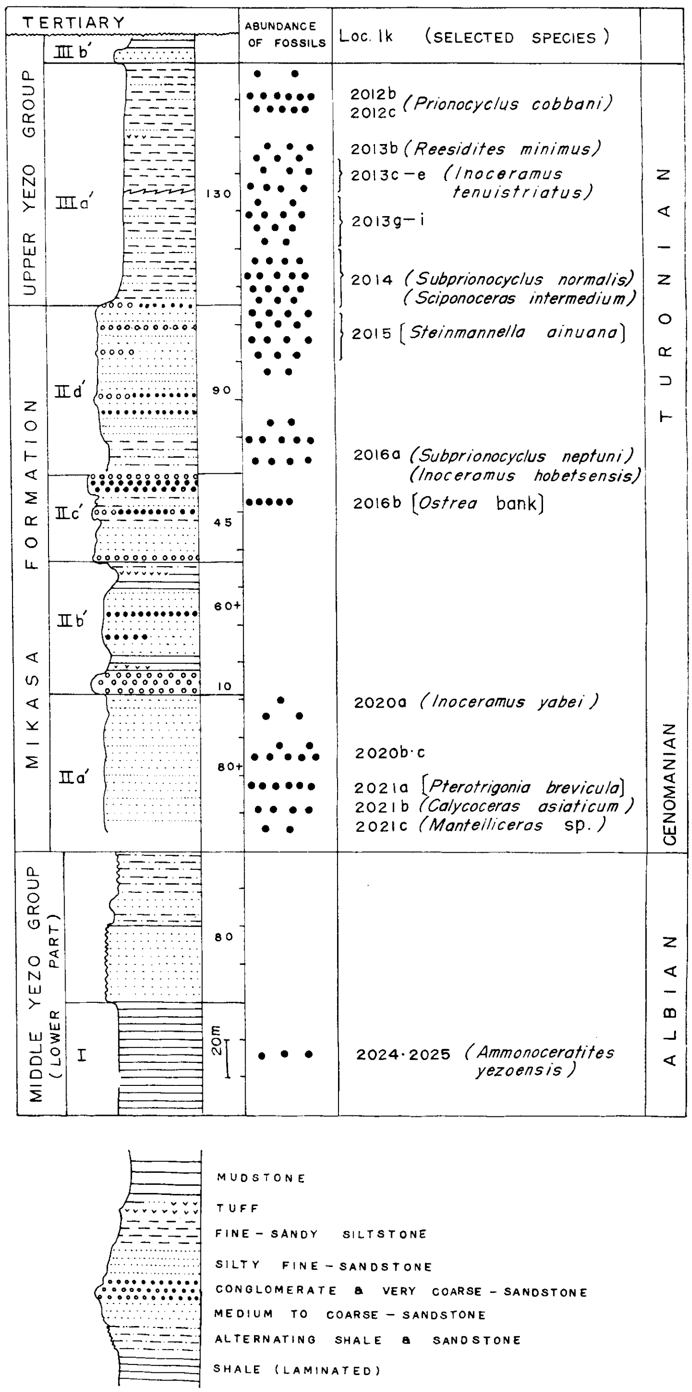

Fig. 5. Columnar section showing the stratigraphic sequence of the Cretaceous sediments along the Pombets. See Fig. 3 for the fossil localities. Lithologic symbols at the bottom. ~~~~~~ (in IIIa′) : Fault.

supplied the valuable specimens for the present study.

Most of the specimens described in this paper are preserved in the Type-specimen Room, Department of Geology, Kyushu University, Fukuoka [abbr. GK.]. Several of them are still in the possession of the Mikasa High School, Mikasa (west of Ikushumbets), Hokkaido.

I had opportunities to study the original specimens of the previously published papers of palaentologic descriptions by M. KAWADA (1929), YABE and SHIMIZU (1925), SHIMIZU (1926, 1932), and HAYASAKA and FUKADA (1951) and also some undescribed specimens preserved at the Geological Institute, University of Tokyo [abbr. GT.], Institute of Geology and Palaeontology, Tohoku University, Sendai [IGPS.], Department of Geology and Mineralogy, Tokyo Kyoiku University [TKU.], and the Department of Geology and Mineralogy, Hokkaido University, Sapporo [GH.]. Some of them are included in the present description and illustration.

Acknowledgements.—I thank many friends for their kindness of supplying me their valuable collections for this study. Their names are to be recorded in the description below, but I should mention here Mr. Tatsuo MURAMOTO and his son Mr. Kikuwo MURAMOTO, Mikasa, Mr. Masanobu KIKUCHI and his students of Mikasa High School, Mr. Tamotsu OMORI, Dr. Keisaku TANAKA, Dr. Nobukazu KAMBE and Dr. Yoshiro UEDA of the Geological Survey of Japan, and Professor Wataru HASHIMOTO of the Tokyo Kyoiku University, without whose cooperation the specimens would not be sufficient for a monographic work. Professor Emeritus Teiichi KOBAYASHI and Professor Fuyuji TAKAI of the University of Tokyo, Professor Kotora HATAI of Tohoku University, Sendai, and Professor Masao MINATO of Hokkaido University, Sapporo, offered me the privilege of studying the valuable collections in the respective institutions. Professor Emeritus Hisakatsu YABE kindly encouraged me.

I am much indebted to Mr. C. W. WRIGHT, London, who critically read the typescript, gave me valuable suggestions and sent me specimens which I wanted to look at, and to Dr. W. A. COBBAN, U. S. Geological Survey, Denver, who freely showed me his fine collections and also the type-localities in the Western Interior Province and gave me plaster casts of type-specimens from North America. My thanks are extended to many other specialists who have helped me in various ways—especially Madame Éliane BASSE de Ménorval, Paris, Dr. Henri BESAIRIE, Tananarive, Général Maurice COLLIGNON, Isère, Professor W. J. DURHAM, Berkeley, Professor Dr. H. K. ERBEN, Bonn, Professor W. M. FURNISH, Iowa, Dr. Otto HAAS, Reno, Dr. L. G. HERTLEIN, San Francisco, Dr. E. C. N. VAN HOEPEN, Hluhluwe, Dr. M. K. HOWARTH, London, Dr. R. W. IMLAY, Washington, D. C., Dr. D. L. JONES, Menlo Park, Professor R. C. MOORE, Laurence, Dr. Ikuwo OBATA, Tokyo, Professor W. P. POPENOE, Los Angels, the late Dr. J. B. REESIDE, Jr., Professor Rinji SAITO, Kumamoto, the late Professor H. G. SCHENCK, Professor Dr. Otto H. SCHINDEWOLF, Tübingen, Dr. Jacques SORNAY, Paris, Dr. Jost WIEDMANN, Tübingen, and Professor Keith YOUNG, Austin.

Dr. Itaru HAYAMI and Dr. Kametoshi KANMERA greatly helped me in improving the photographic work at Kyushu University. A few other photographs were taken at Tohoku University by Mr. K. KUMAGAI and at the University of Tokyo by Chushiro UEKI. Dr. Shozo HAYASAKA and Dr. Masabumi MURATA of Tohoku University, Dr.

Tetsuo HANAI and Mr. Takeo ICHIKAWA of the University of Tokyo, and Dr. Hakuyu OKADA of Kyushu University likewise shared their busy times to help me. Miss Misako KIDO and Miss Tomoko MIYAZAKI assisted me in drafting and type-writing.

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Systematic Descriptions

Order Ammonoidea

Superfamily Acanthocerataceae

Family Collignoniceratidae

Subfamily Collignoniceratinae

Genus *Collignoniceras* BREISTROFFER, 1947

Type-species.—*Ammonites woollgari* MANTELL, 1822 (designated by MEEK, 1876).

Synonymy.—*Prionotropis* MEEK, 1876 (non FIEBER, 1853).

Diagnosis.—The shell is small to moderately large and rather evolute. The whorl is compressed in early growth-stages and less so or even squarish in late growth-stages. The midventral clavi form or tend to form a serrated keel; the serrations correspond in number with the ribs.

The ribs in the young stages are crowded, mostly simple, of nearly equal length, with occassional shorter ones, more or less prorsiradiate, provided at first with outer ventrolateral tubercles and then with both outer and inner ventrolateral ones; weak umbilical tubercles or bullae are developed variably at each second to fifth ribs or may be seen at every rib.

In more or less late growth-stages the ribs are coarse and widely spaced, more or less prorsiradiate and have prominent outer and inner ventrolateral tubercles which are finally united to form strong horns. The umbilical tubercles are removed upward from the umbilical margin and may be finally absorbed by the horned or flared ribs. A few secondary ribs may remain in some adult shells.

The suture consists of E, L, U_2, U_3 [=S], U_1 and I. The elements are less deeply incised and the saddles are rather massive.

Remarks.—Species belonging to this genus are highly variable. Therefore the statement of a diagnosis in a few lines may sometimes cause misunderstanding. Because of the high variability POWELL (1963, p. 1223) regarded *Selwynoceras* as a synonym of *Collignoniceras* and, furthermore, suppressed the generic name *Collignoniceras*. *Prionotropis borealis* WARREN, 1930*, the type-species of *Selwynoceras* WARREN and STELCK, 1940, is quite distinct from *Ammonites woollgari* MANTELL. I would agree with WRIGHT (1957, p. L426) to separate *Selwynoceras* at least subgenerically from *Collignoniceras s. s.* Even if the subgeneric separation is warranted, under the

* Plaster casts of holotype and paratypes of this species are in our University, GK. H9157-H9160.

Rules of the International Code of Zoölogical Nomenclature [Articles 25 (e) (iii) and 60 (a)], *Selwynoceras* should precede *Collignoniceras* and the better known latter name could remain as a subgeneric name. This is too unfortunate, considering the historical background that *Collignoniceras* BREISTROFFER, 1947 was proposed as a substitute name for *Prionotropis* MEEK, 1876, a homonym of *Prionotropis* FIEBER, 1853, and that *Prionotropis* MEEK was established on the basis of the type-species, *Ammonites woollgari* MANTELL, 1822. MEEK's original intention would be too much modified, if we suppress *Collignoniceras* under *Selwynoceras*.

WRIGHT and I intend to apply to the ICZN. to preserve the generic name *Collignoniceras* BREISTROFFER. For the time being this generic name is used in this paper. I should go on to discuss more about the distinction of *Collignoniceras* and *Selwynoceras* and their relations with other genera.

The typical example of *Collignoniceras* is of course *C. woollgari* (MANTELL), which is world-wide in the Middle Turonian. Several other species described under *Prionotropis* (of MEEK), are in our present knowledge, to be referred to *Subprionocyclus*. Examples of *Selwynoceras* are, besides the type-species, *S. schlueterianum* (LAUBE and BRUDER), *S. fleuriausianum* (D'ORBIGNY), *S. papale* (D'ORBIGNY), *S. papaliforme* (LAUBE and BRUDER), *S. canthus* (D'ORBIGNY), *S. turoniense* (SORNAY) and *S. mexicanum* (BÖSE). The last species has features apparently intermediate between *Selwynoceros* and *Collignoniceras* (*s. s.*), as I have already pointed out (MATSUMOTO, 1959b, p. 106). The subgeneric diagnosis and distinction may be written as follows:

Subgenus *Collignoniceras* [type-species: *C.* (*C.*) *woollgari* (MANTELL)].—The ventral keel is more continuous than in *Selwynoceras*, especially in the adolescent and preceding growth-stages. The ribs are remarkably projected on the venter, forming chevrons. On the outer whorls secondary or intercalated ribs are almost absent or occur infrequently.

Subgenus *Selwynoceras* WARREN and STELCK, 1940 [type-species: *C.* (*S.*) *borealis* (WARREN)].—The ventral keel is not well developed, but represented by a train of discontinuous midventral clavi. The ribs are not much projected on the venter. The secondary or intercalated ribs persist up to later stages of growth and occur more frequently than in *Collignoniceras*.

The distinction is clear between the typical examples, but may be somewhat obscured between some variants. Although the extents of variation approach to each other, subgeneric separation seems to be taxonomically desirable. Stratigraphically species of *Selwynoceras* mostly occur in the Lower Turonian and those of *Collignoniceras* (*s. s.*) in the Middle Turonian, although there may be a few exceptions. The existence of a minority of intermediate species does not form a reason for making objection to the separation.

The origin of *Selwynoceras* is said to be in such a genus as *Neocardioceras* SPATH, 1926 (see WRIGHT, 1957, p. L 426). Unfortunately *Neocardioceras* itself is not well known to us, since it is represented in published illustration by a few, small, probably immature specimens. Its origin, in turn, is said to be sought in *Protacanthoceras* SPATH, 1923, which is again represented by species of comparatively smaller dimensions even in the adult stage. Nine, small, specimens of *Neocardioceras*, from England, are before me, which I have borrowed from C. W. WRIGHT. Their ribs show chevrons on the venter. From this and other features I am rather inclined to consider the possibility that *Neocardioceras*, of the Lower Turonian, could be a direct anecestor of *Collignoceras* (*s. s.*), of the Middle Turonian. On the other hand *Protacanthoceras*, as represented by immature specimens from England (SHARPE, 1853; JUKES-BROWNE, 1896; WRIGHT and WRIGHT, 1951) and also by adult ones from Israel (AVNIMELECH and SHORESH, 1962), fairly resembles *Selwynoceras*. Yet the available evidence is insufficient to decide one of the two alternatives that *Selwynoceras* was derived directly from *Protacanthoceras* and *Collignoniceras* from *Neocardioceras* or that *Selwynoceras* was derived from *Protacanthoceras* by way of *Neocardioceras* and *Collignoniceras* from *Neocardioceras* by way of *Selwynoceras*. Morphologically *Collignoniceras* (*s. s.*) and *Selwynoceras* both show hypernodosity on the outer whorl. They, thus, resemble so closely each other in the adult stage and also through variations that the subgeneric rather than generic separation is desirable in our present state of knowledge. Incidentally *Neocardioceras* and *Protacanthoceras*, which have more or less compressed shells, have been classified in the subfamily Acanthoceratinae, but I suggest that they could be connected with such a compressed genus as *Eucalycoceras* SPATH, 1923 of the Mantelliceratinae. In this genus ribs are predominant over tubercles and the ornament is weakened on the outer whorl, without hypernodosity. The character of hypernodosity in the adult shell, which must be related to a particular mode of life, may not necessarily persist in a particular line of evolution, but can occur repeatedly in various evolutional lines of the Acanthocerataceae. *Collignoniceras* (*s. s.*) is likely a source of *Prionocyclus* MEEK and *Subprionocyclus* SHIMIZU. As is described below more precisely, the high plasticity shown by *Collignoniceras woollgari*, for instance, is, in my opinion, significant in that it can be interpreted as foretelling the characters of these descendants.

In Hokkaido no examples of *Selwynoceras* have been found and only a few, small, probably young specimens of *Collignoniceras woollgari* (MANTELL) are known. Before entering into the description of the examples from Japan, remarks are given on the diagnosis, variation and affinities of this "well known" species.

Collignoniceras woollgari (MANTELL)

Pl. 1, Figs. 1-6; Pl. 2, Figs. 1-3; Pl. 3, Figs. 1-2; Text-fig. 6

1822. *Ammonites woollgari* MANTELL, *The fossils of the South Downs*, p. 197, pl. 21, fig. 16.
1855. *Ammonites woollgari*, SHARPE, *Palaeontogr. Soc.*, 1854, p. 27, pl. 11, figs. 1, 2.
1876. *Prionocyclus* (*Prionotropis*) *woolgari*,* MEEK, *U. S. Geol. Surv. Territories*, vol. 9, p. 455, pl. 7, fig. 1a-h; pl. 6, fig. 2.
1946. *Prionotropis woollgari*, HAAS, *Bull. Amer. Mus. Nat. Hist.*, vol. 86, p. 150, pls. 11-16; text-figs. 1-14.
1951. *Collignoniceras woollgari*, WRIGHT and WRIGHT, *Palaeontogr. Soc.*, 1950, p. 30.
1956. *Collignoniceras woollgari*, COBBAN, ROHRER and ERDMANN, *Jour. Paleont.*, vol. 30, p. 1269, text-figs. 1B-H.
1958. *Collignoniceras woollgari* (recte *woolgari*), MATSUMOTO and MILLER, *Jour. Paleont.*, vol. 32, p. 353, pl. 44, figs. 1-6; pl. 45, fig. 1.

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* Misspelling frequently cited by American authors.

1963. *Collignoniceras* cf. *woollgari* WRIGHT, *Palaeontology*, vol. 6, p. 610, pl. 86, fig. 3; pl. 89, fig. 4.

Diagnosis.—This species is dimorph, showing a considerable difference between the shells of early and late growth stages. The young shell is considerably variable as is described below. Typically it is rather evolute, with an umbilicus of moderate size. The first and the second whorls are smooth and roundish. The whorls over 3 mm. or so in diameter are compressed, provided with a continuous, serrated, siphonal keel and ornamented on the flank with numerous, rather crowded, prorsiradiate ribs, which have at first outer ventrolateral tubercles and then inner and outer ventrolateral ones and also more or less weak umbilical bullae. The serration of the keel corresponds with each rib.

Sooner or later in the adolescent stage, with diameters over 20 mm or 30 mm, the specific diagnosis is well presented. The whorl in this stage is compressed, especially in the intercoastal section, ornamented on the flank with distant, prominent, prorsiradiate ribs, each of which is normally provided with umbilical and two ventrolateral tubercles. The umbilical tubercle is bullate and highest at a point somewhat above the umbilical margin; the inner ventrolateral one is conical, the outer ventrolateral one is clavate and fairly close to the keel. The ribs are strongly projected on the venter, forming chevrons. The keel on the mid-venter is narrow, continuous and highly serrated. A serration corresponds with each rib and is much higher than the outer ventrolateral clavi; it is of asymmetric shape with forward slope much steeper than that of the rear.

In the adult stage, with diameters over 100 mm or so, the whorl is subquadrate even in the intercostal section. The ribs are strong, very distant, about dozen per whorl. Each rib is provided with a ventrolateral horn which is developed from the inner ventrolateral tubercle absorbing the outer ventrolateral one. The umbilical tubercle is removed upward and may form a lateral flare of the rib or may even tend to be absorbed by the ventrolateral horn. The ribs are somewhat prorsiradiate on the flank and projected on the venter, if not so remarkably as in the adolescent stage. The keel is less prominent than in the adolescent stage, being represented by a row of mid-ventral clavi and low elevations between them. Minor riblets and corresponding smaller ventral clavi may be occasionally developed on the venter.

The suture consists of E, L, U_2, U_3 [=S], U_1 and I. In the young stage E is larger than L; in the late stage L is narrower but somewhat deeper than E. I is deep and narrow. The saddle between E and L is massive, broad, subquadrate and roughly bifid. Minor indentations are rather shallow. The suture is considerably variable in minor details.

Variation.—In addition to the hitherto described examples, I have examined a large number of smaller specimens of this species obtained from a bed about 10 meters above the base of the Carlile Formation, at a locality (TM. 31) 2 miles southwest of New Castle, Wyoming. There is a considerable extent of variation especially in the young stages. I have recognized the following kinds of variation, although they may grade one to another; I do not intend to give names for these variants; they may in part, if not wholly, correspond to what HAAS (1946) classified as forma

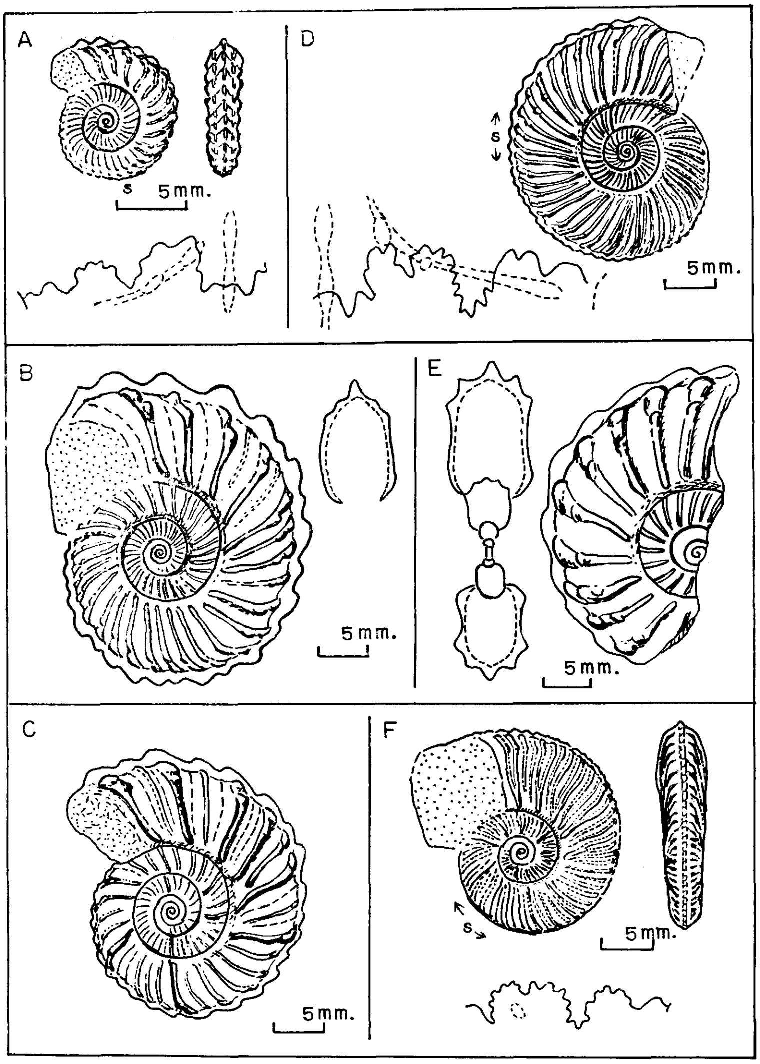


Fig. 6. Diagram showing immature shells of highly plastic *Collignoniceras woollgari* (MANTELL). Figures are drawn on the basis of the representative specimens, from loc. TM. 31, 2 miles sowthwest of New Castle, Wyoming, as indicated below, sometimes slightly restored. (See also Plates 1-3). A: GK. H7504 of Group A, in which the *woollgari* type coarse ornament appears very early in ontogeny; B: GK. H7447 of Group B, which can be regarded as the most typical representative of *C. woollgari*; C: GK. H7495, of Group C, which is characterized by ribs of unequal intensity, foreshadowing *Prionocyclus hyatti*; D: GK. H7496 of Group D, characterized by the persistency of crowded, fine ribs with two ventro-lateral tubercles, resembling *C. woollgari bakeri*; E: GK. H7453 of Group E, which has regularly and gradually distant ribs and a subrectangular whorl-section, foretelling *Subprionocyclus branneri*; F: GK. H7494, which is characterized by dense, fine, flexuous, often branching and inserted ribs with late appearing inner ventro-lateral tubercles, foreshadowing *Subprionocyclus hitchinensis* or immature *S. neptuni*.

(T. M. *delin.*)

typica and varieties *intermedia*, *regularis*, *crassa* and *tenuicosta*.

A. Rare examples, as represented by the specimen GK. H7504, (Fig. 6A) (Pl. 1, fig. 1) in which faint ribs begin to appear as early as the late part of the second whorl, the double ventrolateral tubercles begin to appear at the end of the third whorl with a diameter slightly over 4 mm, and the distant and coarse ribbing and high serration of the keel begin to develop already in the middle of the fourth whorl at a diamenter of 8 mm. The ribs are all simple and almost equally long, but some are slightly weaker than others.

B. A fairly abundant group, represented by specimens GK. H7447 (Fig. 6B) (Pl. 2, fig. 2), H7442 (Pl. 2, fig. 3), H7498 (Pl. 1, fig. 2), H7502 (Pl. 1, fig. 3), etc., in which the ribs begin to appear at about the middle of the third volution, the densely costate stage continues for about two whorls up to a diameter of 20 mm or so, where ribs are about 33 per whorl. This is succeeded by the stage in which ribs become quickly distant and coarse and the serration on the keel becomes high. The ornament of the adolescent type is, thus, acquired in a moderate growth-stage (not very early nor very late). The outer and inner ventrolateral tubercles are well developed from the middle of the fourth whorl (at a diameter of about 10 mm) onward. The ribs are simple, almost equally long, but at first each sixth or fifth and then each fourth or third ribs and finally alternate ribs are somewhat stronger than the others and provided with umbilical bullae. In the distantly costate stage the intercalated rib may remain as a much reduced, faint riblet. This may give rise to a minor serration in addition to the high serration on the keel.

C. A group of considerable abundance, as represented by the specimens GK. H7495 (Fig. 6C) (Pl. 1, fig. 4), H7495, etc., in which simple ribs begin to appear at about the middle of the third whorl, being at first faint and then in the fourth whorl moderately strong, separated by interspaces nearly as narrow as the ribs themselves, although at irregular intervals ribs are somewhat stronger than others and provided with umbilical bullae. The double ventrolateral tubercles are developed already in this stage. Sooner or later in the fifth whorl the ribs are separated by broader interspaces. Again some of them are variably stronger than others at irregular intervals. In the sixth whorl primary ribs are much distant and strong, being provided with prominent, double (i. e. approximated inner and outer) ventrolateral tubercles and also umbilical tubercles somewhat above the umbilical margin. Weaker secondary ribs and/or faint riblets are intercalated between the strong primaries; they are free from umblilical bullae but some of them have small, double, ventrolateral tubercles. Thus this subgroup is characterized by ribs of unequal intensity.

D. Another group of considerable abundance, represented by the specimens, GK. H7496 (Fig. 6D) (Pl. 3, fig. 2), H7499 (Pl. 1, fig. 5), H7493, etc., in which ribs with or without umbilical bullae appear in the middle of the third whorl as in the case of B, and the crowded, narrow ribbing persists longer than in B. Thus, at a diameter of 25 mm in an example, the ribs are as numerous as 45 per whorl and in the preceding whorl 40. They become gradually and rather slowly distant in the stage with diameters over 25 mm and then comes the adolescent stage with much distant and coarse ribs. In the densely costate stages, the ribs are mostly simple, prorsiradiate and straight on the flank but some of them show slight flexuosity; they are nearly equally long but some of them may be slightly shorter than others, starting at a point a little above the umbilical margin as intercalaries or occasionally at a point so close to the umbilical bullae of the longer one as almost to show bifurcation. At diameters over 15 mm each rib is provided with small but distinct outer and inner ventrolateral tubercles; the umbilical bullae are developed on some of the longer ribs, at first at every sixth, fifth or fourth rib and then more frequently. Since the ribs are narrow and ventrolateral tubercles are small, the serration on the continuous keel that corresponds to the ribbing is rather fine and low in the densely costate stages. The shell of this subgroup is flatly discoidal and has an umbilicus of moderate width (about 34 percent of a diameter in an example), with little involution of the whorls.

E. A group of a considerable abundance, represented by GK. H7453a (Fig. 6E) (Pl. 2, fig. 1), in which ribs are comparatively coarser than in others even in the early stage and become slowly distant. Thus the difference between young and late stages is not so remarkable in this group as in others. The ribs are all simple, less prorsiradiate than in B, almost equally long and strong, and provided with umbilical bullae, conical inner and clavate outer ventrolateral tubercles. The serration on the keel is moderately high. The shell of this subgroup is less compressed than in others and its whorl section is subrectangular.

F. A group of a considerable abundance, represented by the specimens GK. H7494 (Fig. 6F) (Pl. 3, fig. 1), H7467, 7465, etc., in which the ribs are dense and numerous in the young stage. They appear in the third whorl and are mostly simple and almost equally long for about a whorl, although some of them are periodically stronger than others on the umbilical margin, having weak umbilical bullae. In the succeeding stage, at diameters from 8 mm to 20 mm in one example, the ribs are still crowded and somewhat flexuous, of various length, some branching from the longer ones near the umbilical bullae, others intercalated. All the ribs have outer ventrolateral tubercles, but the umbilical bullae are developed only at the end of the longer ones. Thus, about a dozen umblilical bullae are counted per whorl as compared with 55 ventrolateral tubercles. The serration on the continuous keel is very fine but well corresponds to each rib. The inner ventrolateral tubercle is not developed in this stage but a slight bending of the rib is seen at the site where inner ventrolateral tubercle should be developed in later stages. The whorl of this subgroup is much compressed, growing rather rapidly and, accordingly, fairly narrowly umbilicate (less than 30 percent of a diameter). The characters of the adolescent stage are the same as those of other subgroups.

Affinities.—The above described variation in the young stages is very interesting in that it shows affinities to certain other species. Group B may be regarded as representing the most typical *Collignoniceras woollgari*. Group A may also be rather typical but the ornament of the adolescent stage is so to speak accelerated. Group C foretells *Prionocyclus hyatti* (STANTON) of a higher zone. Group D resembles the subspecies *C. woollgari bakeri* to be described below, although it has smaller umbilicus than the latter. Group E foreshadows *Subprionocyclus branneri* (ANDERSON) [=*S. cristatum* (BILLINGHURST)] of the Upper Turonian and group F resembles the young shell of *Subprionocyclus neptuni* (GEINITZ) or *S. hitchinensis* (BILLINGHURST) of the Upper Turonian.

The specimens from Japan are very close to those from Oregon and California, which constitute a subspecies defined below:

Collignoniceras woollgari bakeri (ANDERSON)

Pl. 3, Figs. 3, 4

1902. *Schloenbachia bakeri* ANDERSON, *Proc. Calif. Acad. Sci.*, 3rd ser., vol. 2, p. 121, pl. 2, figs. 26-33.
1958. *Prionotropis bakeri*, ANDERSON, *Geol., Soc. Amer., Memoir* 71, p. 261, pl. 38, figs. 2-5.
1958. *Calycoceras (Metacalycoceras) auspicium* ANDERSON (*pro parte*), *Geol. Soc. Amer., Memoir* 71, p. 243, pl. 20, fig. 9 (*non* fig. 8).
1959. *Collignoniceras woollgari*, MATSUMOTO, *Mem. Fac. Sci., Kyushu Univ., ser. D, Geol.*, Special vol. 1, p. 105, text-fig. 55-57.

Lectotype.—ANDERSON (1902, p. 122) seems to have considered a single specimen as the type of his *Schloenbachia bakeri*, but actually he did not clearly designate which it was and described and illustrated a number of syntypes. What he recorded as the holotype in his redescription (ANDERSON, 1958, pl. 38, fig. 3) [=ANDERSON, 1902, pl. 2, fig. 26], from loc. C. A. S. 445, "Forty-nine" mine, near Phoenix, Oregon, is in fact the lectotype. Its plaster cast is in Kyushu University, with register number GK. H9116.

Material.—The specimens to be described here are GK. H5481 (Pl. 3, fig. 3)-H5487, from loc. T1022p7, a rolled block derived from the Saku Formation, with abundant *Inoceramus hobetsensis nonsulcatus*, Saku-gakko-zawa, Teshio Province, Hokkaido. IGPS. 36833 (several specimens in a nodule), from Hokkaido, without precise locality record, are referable to this subspecies. I have also examined the specimens from Oregon and California (T. M., 1959).

Subspecific diagnosis.—This is a subgroup of individuals of *Collignoniceras woollgari*, distributed in the northern Pacific region. It is characterized by a compressed, discoidal shell, relatively slow growth of whorls, wide umbilicus, persistency of the crowded, numerous ribs, which are mostly simple, nearly equally long, and provided with small, inner and outer ventrolateral tubercles, and umbilical bullae. Ribs are somewhat, but not very strongly, prorsiradiate, mostly straight but occasionally slightly flexuous on the flank, bent at the inner ventrolateral tubercle and projected on the venter. Some of the umbilical bullae may be stronger than others and there are also some ribs which are almost free from the bullae. The ventral keel is continuous and the serration is weak. The mature shell, with coarse and distant ribs, prominent ventrolateral tubercles and highly serrated keel, seems to be similar to that of the typical group of *C. woollgari*, but the character may appear less abruptly than in the typical form, with gradual increase in the spacing of the ribs.

Measurements.*—

Specimen	Diameter	Umbilicus	Height	Breadth	B/H	Ribs
H9116	27.2	10.5(0.39)	10.0	7.4	0.74	42
H5481	20.7	8.6(0.41)	6.8	5.0	0.73	46
H5483	17.8	7.3(0.41)	6.3	4.3	0.68	43
H5484	21.0	8.6(0.41)	7.8	5.6	0.71	48

Remarks.—When I described the specimens from California and Oregon (T. M., 1959), *Schloenbachia bakeri* ANDERSON, 1902 was regarded as a synonym of *Collignoniceras woollgari*. The Japanese specimens from one and the same locality show a fairly constant character in the young stage and that character is identical with that of the specimens from Oregon and California. The group is very close to subgroup D of *C. woollgari* from the Western Interior province, but is more widely umbilicate and has less prorsiradiate ribs. I am, therefore, inclined to regard the group from the northern Pacific region as a subspecies of *C. woollgari*, for which *bakeri* is the appropriate subspecific name.

Adult shells of this species occur very rarely in Japan. A fragmentary whorl in MURAMOTO's collection, from the upper part of the Mikasa Formation (zone of *Inoceramus hobetsensis*) in the Ikushumbets Valley may be an example.

Occurrence.—Rare in Hokkaido: loc. T1022 p7, from the Saku Formation, in the Abeshinai-Saku area, Teshio Province; another locality in the Ikushumbets Valley, upper part of the Mikasa Formation, Ishikari Province. They belong to the zone of *Inoceramus hobetsensis*, i. e. the middle part of Upper Gyliakian, approximately Middle Turonian. Another locality in Hokkaido, where IGPS. 36833 was found, is not precisely recorded.

Genus *Prionocyclus* MEEK, 1876

Type-species.—*Prionocyclus wyomingensis* MEEK, 1876 [=*Ammonites serratocarinatus* MEEK, 1872 (*non* STOLICZKA, 1865)] (by original designation).

Diagnosis.—The shell is moderate to large. The whorl is compressed, subquadrate in section, and provided with a continuous mid-ventral keel, which is finely serrate on top and may look entire on an internal mould. The serrations are more numerous than the ribs. The keel is usually bordered by narrow and shallow grooves.

The ribs are irregular in length and strength, typically crowded on young whorls and become distant, with reducing secondaries, on outer whorls. They are nearly rectiradiate or somewhat prorsiradiate on the flank, abruptly bent at the ventrolateral tubercles and projected more and more on the venter as they approach the keel, tending to join in the keel or to run away in parallel with the keel, with decreasing strength.

The umbilical tubercles are bullate and situated at or somewhat above the

* Measurements of dimensions are in millimeters; the proportion to diameter is indicated in parentheses.

umbilical shoulder. The inner ventrolateral tubercles, which are located at the ventrolateral shoulder, are prominent and may become spinose or horn-like. The outer ventrolateral tubercles, if existent, are always weaker than the inner and situated at a point between the ventrolateral shoulder and the mid-venter. In many cases, however, they are obsolete or tend to be absorbed by the ventral ribs or by the marginal horns. Some ribs may be bifurcated at the umbilical bullae and occasionally be looped at the ventrolateral tubercles.

The suture is similar to that of *Collignoniceras*.

Remarks.—In a footnote to HAYDEN's report (1872, p. 298) MEEK suggested a new generic name *Prionocyclus* for *Ammonites* (*Pleurocersas* ?) *serrato-carinatus* MEEK. Because *Ammonites serrato-carinatus* had been preoccupied by STOLICZKA (1865) for another distinct species, MEEK (1876, p. 452, footnote) proposed the specific name *wyomingensis* for his *serrato-carinatus*. In the same paper (MEEK, 1876, p. 452-454) the genus *Prionocyclus* was clearly defined and distinguished from *Pleuroceras* HYATT, 1867, a Lower Jurassic homoeomorph. MEEK (1876) subdivided the genus *Prionocyclus* into two subgenera, *Prionocyclus* (*s. s.*) and *Prionotropis*, which were later treated as distinct, but closely related, genera.

The syntypes of *Prionocyclus wyomingensis* were not illustrated by MEEK himself. Drawings were first given by WHITE (1880, p. 35, pl. 15, figs. 1a-e), and were reproduced by STANTON (1894, p. 171, pl. 40, figs. 1-4), GILBERT (1896, p. 565, pl. 58, figs. 1-3), LOGAN (1898, p. 463, p. 106, figs. 1-4), GRABAU and SHIMER (1910, p. 228, fig. 15, 10a-d), etc. The illustrated syntypes are three but have received the same register number, USNM. 7729, the plaster casts of which were donated to the Kyushu University. Photographs of these plaster casts in our University (GK. H9019a-c) are given in this paper. The original specimen of STANTON's (1894) pl. 40, fig. 3 [=WRIGHT *in* MOORE [Ed.] 1957, fig. 547-6a] [Pl. 16, Fig. 1, in this paper, of a plastotype, GK. H9019c], from the valley of the Medicine Bow river, Frontier Formation, southeast Wyoming, is designated here as the lectotype, although two other syntypes from the same locality are also good examples of the same species. One of the syntypes (STANTON, 1894, pl. 40, fig. 2=WRIGHT *in* MOORE [Ed.], 1957, fig. 547-6b), which has a diameter of 112 mm and is nearly as large as the lectotype, is still septate and the three specimens should be regarded as immature. HAAS (1946, p. 202-203, pl. 20, figs. 1, 2, 5) illustrated a large specimen, which is still septate at a diameter of 250 mm. COBBAN kindly showed me large adult shells of his collection in U. S. G. S., Denver, and I myself fortunately obtained another large specimen (GK. H7880), in which the body whorl is 107 mm. high and 75 mm. broad in intercostal section (Pl. 18, Fig. 1). In these large specimens, which certainly represent the adult stage of *Prionocyclus wyomingensis*, the whorl is roughly rectangular in section and the ribs are coarse and distant*i* though disposed at irregular intervals, and mostly provided with marginal horn-like tubercles, which are septate near the base. Even in the inner whorl, as seen in a syntype (Pl. 16, Fig. 1), the ventrolateral tubercles are spinose and extended along the umbilical wall of the outer whorl.

From the above observation on the type-species it follows that the presence cr absence of hypernodosity cannot be a criterion to distinguish *Prionocyclus* from *Col-*

lignoniceras. The distinction of the two closely related genera may be stated as follows. In *Prionocyclus* the ribs are projected more and more on the venter, tending to thin away as they approach the keel, and the fine serrations on the summit of the keel are more numerous than the ribs, while in *Collignoniceras* the ribs cross the keel, forming more or less acute chevrons, and the serration on the keel is coarse and high in the adolescent stage and corresponds exactly in number with the ribs. The keel, thus, looks more continuous in *Prionocyclus* than in *Collignoniceras* and is accompanied by shallow grooves on its sides. As a general tendency the ribs of *Prionocyclus* are more irregular in length and intensity than those of *Collignoniceras*, but this character is not fixed in the two genera. Likewise the fineness of the ribbing would not be accounted a good criterion for the distinction. HAAS (1946) has already demonstrated that *Prionocyclus wyomingensis* shows considerable variation in this respect as does *Collignoniceras woollgari*. In *Prionocyclus* the outer ventrolateral tubercles tend to be reduced but this character cannot be said to be established throughout the genus.

On the basis of the above criteria I am inclined to transfer *Prionotropis hyatti* STANTON, 1894 from *Collignoniceras* to *Prionocyclus*, as POWELL (1963, p. 1220) has recently done. The two illustrated syntypes (STANTON, 1894, p. 176, pl. 42, figs. 5-8), with a common register number USNM. 22941 [plaster casts in our University, GK. H9162 and GK. H9163] are both undoubtedly immature; the larger one (STANTON, 1894, pl. 42, figs. 5, 6) [Pl. 17, fig. 3 in this paper for GK. H9162] is here designated as the lectotype. The specific diagnosis may not be fully manifested on these small specimens, although the lectotype shows the coarsely ornamented and subquadrate whorl of adolescent type in spite of its small size.

I studied in the United States numerous examples of various growth-stages of *Prionocyclus hyatti*, from the Blue Hill Shale Member in Kansas, the Dark Shale Member of Carlile Formation in Colorado and Wyoming, and also the Mancos Formation in New Mexico. This species is again fairly variable in the fineness of the serration on the keel, the ratio in number of primary and secondary ribs, the proportion between height and breadth of the whorl; the finely ribbed, compressed whorl becomes coarsely ornate and subquadrate at various diameters. Moreover, a variant (group C) of immature *Collignoniceras woollgari* is fairly close to a certain immature examples of *Prionocyclus hyatti*, as has been described in the preceding page. *P. hyatti* is morphologically and stratigraphically situated between *C. woollgari* and *P. wyomingensis*. Therefore, it is a matter of convention whether to refer the species *hyatti* to *Collignoniceras* or to *Prionocyclus*, but on the grounds of the above described criteria for generic distinction, it would be better to refer it to *Prionocyclus* than to *Collignoniceras*. I would also agree with POWELL in regarding *Prionotropis eaglensis* ADKINS, 1928, from Texas and New Mexico, as identical with *Prionocyclus hyatti*. When I visited (in 1957) the University of Texas, I recognized numerous specimens of *P. hyatti* in the collections of BEG. and UT., from the so-called condensed zone, top member of the Eagle Ford Formation, Travis County, Texas and from other localities in central and western Texas and northeastern Mexico. Some of them (small specimens) are identical with the STANTON's syntypes. Other large ones are indistinguishable from adult shells of *P. hyatti* from Kansas and Colorado on one hand and also from holotype (BEG. 609) of *Prionotropis eaglensis* ADKINS (1928, p. 250, pl. 32, figs. 1, 2) on the other.

Incidentally the type specimens of *Ammonites graysonensis* SHUMARD, 1860, as illustrated by WHITE (1883, pl. 18, fig. 9a, b), could possibly be identical with immature *P. hyatti* (STANTON) and *Ammonites novi-mexicani* MARCOU, 1858 (p. 35, pl. 1, fig. 2), whose type is BM. C49764 [plaster cast of which is GK. H9165], from Albuquerque, New Mexico, closely resembles the whorl in middle growth-stage of *Prionocyclus wyomingensis* MEEK, but the available evidence is insufficient for a final conclusion of identity.

The following species are to be referred to *Prionocyclus*:

P. hyatti (STANTON) (1894)
P. macombi MEEK (1876)
P. wyomingensis MEEK (1876)
P. reesidei SIDWELL (1932)
P. quadratus COBBAN (1953)

As has been excellently worked out by COBBAN (1951, 58), the above listed species occur in ascending order in the Cretaceous sequence of the Interior Province of the United States. They are, together with the associated species of *Scaphites* and *Inoceramus*, good guide fossils of the zones in the Upper Turonian in that province above the zone of *Collignoniceras woollgari*.

While *C. woollgari* and the first three species of *Prionocyclus* occur in abundance, the last two species are at present represented by a small number of specimens. The data so far available seem to show that these serial species have changed in geographical distribution from world-wide, through regional, to local. *C. woollgari* is world-wide; *P. hyatti* has a regional distribution in both the Interior and the Gulf Coastal provinces; the other four species of *Prionocyclus* are known only in the Western Interior province, of which the last two seem to occur in restricted areas. The reason for this fact deserves to be specially studied.

The above mentioned serial species of successive stratigraphic occurrence may not necessarily represent a single line of evolution. As has been discussed above, *P. hyatti* must have been derived from certain populations of *C. woollgari*.

Prionocyclus macombi MEEK (1876b, p. 132, pl. 2, fig. 3a-d; STANTON, 1894, p. 172, pl. 41, figs. 1-5) is not typical of this genus and MEEK himself referred it to *Prionocyclus* with a query. It has much compressed whorls almost throughout life, weak ribs even on the comparatively outer whorl and no perceptible grooves on either side of the keel. Its outer ventrolateral tubercles are almost completely obsolete. *P. hyatti* is indeed variable, but *P. macombi* does not seem to be connected with any of the variants of that species. It may have some relation with a finely ribbed and compressed variant of *C. woollgari*, but the relation is probably indirect. In other words some undescribed species can be expected between the two species. In the essential features, such as subrectangular whorl section with a flat venter, fairly strong ventrolateral tubercles, ribs of unequal length and strength, etc., *P. macombi* can well be assigned to *Prionocyclus*. In fact it resembles to some extent a compressed and weakly ribbed variety (young shell) of *P. wyomingensis*, as represented by one of the syntypes (the original of STANTON, 1894, pl. 40, fig. 2) [plaster cast in our University, GK. H9019b] and another specimen (GK. H7429) in my collection from loc. TM. 48, about 7.5 miles NNW of Belle Fouche, Butte County, South Dakota, Turner Sandy Shale Member of the Carlile Formation.

As regards the well known species *P. wyomingensis*, nobody has clarified in detail its direct ancestry, although it may be suggested that *P. hyatti* is intermediate in some respects between *C. woollgari* and *P. wyomingensis*.

P. reesidei SIDWELL (1932, p. 318, pl. 49, figs. 10-12) seems to be more closely allied to *P. hyatti* than to *P. wyomingensis* in shell-form and ornamentation. In *P. reesidei* the keel is more finely serrated than in *P. hyatti*, the outer ventrolateral tubercle is almost completely obsolete and a faint lateral bulge is discernible on the ribs of the outer whorl.* In these and other respects this species can be regarded as a direct ancestor of *P. quadratus* COBBAN (1953, p. 354, pl. 48, figs. 1-8), which is characterized by a subquadrate and inflated outer whorl and an incipient lateral node below the large ventrolateral one on each of the coarse ribs. The lateral nodes in these two species may be regarded as a new character but are so indistinct that the establishment of a new genus or subgenus for these two species would not be warranted, unless more distinctly multituberculate species were found.

In contrast to the abundant occurrence of *Prionocyclus* in the Interior and Gulf Coast provinces of North America, unmistakable examples of the genus have not been monographed from other areas. Some species from Europe or other extra North American areas which were formerly referred to this genus have proved to belong to other genera, such as *Prionocycloceras* and *Subprionocyclus*. Since several examples of *Prionocyclus* occur in Japan, the geographical distribution of this genus must be actually wider than is at present known. This requires careful collecting in the future.

In Japan two species of *Prionocyclus* were recorded from a limited part of the Cretaceous sequence of Hokkaido (MATSUMOTO, 1959b, p. 66). Although they were preliminarily noted as related to the known species (*P. macombi* and *P. reesidei*) from America, they have their own particular characters as described below. One of them, "*P.* n. sp. aff. *P. macombi*", is so peculiar that I am going to establish a new genus for it. The other species, "*P.* n. sp. aff. *P. reesidei*", is in this paper separated into two new species, of which one is again rather abnormal. The three species occur in sediments of a particular facies which probably represents a relatively western, inshore part of the Upper Cretaceous marine basin in Hokkaido.

Prionocyclus cobbani sp. nov.

Pl. 4, figs. 1-4; Text-fig. 7

Material.—Holotype: GK. H5432 (Pl. 4, Fig. 1) from loc. Ik 2012c, a gully on the right side of the Pombets [=Ponbetsu], a tributary of the Ikushumbets, central

* The holotype (a plaster cast of which is in Kyushu University, GK. H9281 [Pl. 17, Fig. 1]) is immature and does not show this feature.

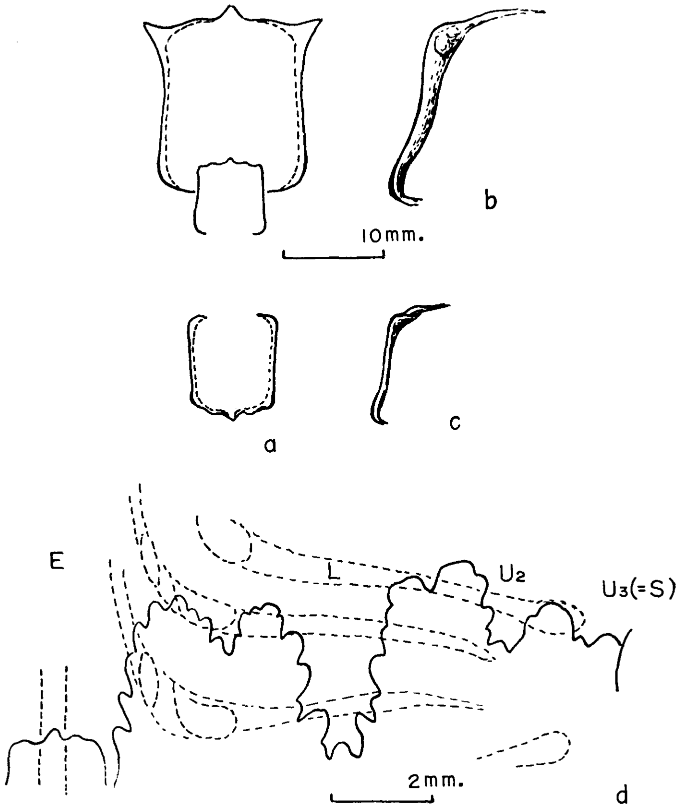


Fig. 7. *Prionocyclus cobbani* n. sp. Holotype, GK. H5432, from loc. Ik2012, Pombets. (a) Whorl-section; (b) primary rib on the body-whorl; (c) that on the septate whorl; (d) last sixth suture at whorl-height=10 mm. (T. M. *delin.*)

Hokkaido. It was found by T. MURAMOTO (P2217) in a calcareous nodule contained in the 15 m thick, dark gray, fine-sandy siltstone, belonging to the zone of *Inoceramus teshioensis-I. tenuistriatus*, about 10 m below the green sandstone bed (6 m), lower part of the Upper Yezo Group. It has both the body- and septate whorls, but the former is somewhat destroyed. There is a number of other specimens obtained by T. MURAMOTO, T. OMORI and T. MATSUMOTO from the same bed exposed at the type-locality Ik 2012c, of which the illustrated paratypes are GK. H5431, H5433, and H5480.

The specific name is dedicated to Dr. W. A. COBBAN, who kindly showed me his fine collection of the Collignoniceratidae from the Western Interior province and the typical exposures of the Cretaceous sequence there.

Diagnosis.—The shell is small, about 45 mm. in diameter in the holotype. It is discoidal, consisting of moderately growing, moderately involute whorls, with an umbilicus of moderate width (about 28-35 percent of a shell diameter).

The whorl is higher than broad, subrectangular in cross section, with flattened or only gently inflated flanks, shallow but steep, nearly perpendicular umbilical wall,.

abruptly rounded (on intercostal part) to subangular (on costal part) umbilical and ventrolateral shoulder, and gently arched, narrow venter. The mid-ventral keel is distinct, narrow, and finely serrate. It may be bordered by shallow grooves. The serrations are about two to three times as numerous as the ribs. They may be reduced.

The ribs are simple, somewhat irregular in length and strength. The body-whorl has distant primary ribs with few secondaries, while the septate whorls have crowded primaries and secondaries, but the density may vary between individuals. The primary ribs start at the umbilical margin with a backward inclination, bent at the umbilical shoulder, nearly rectiradiate or slightly prorsiradiate or slightly flexiradiate on the flank, abruptly bent at the ventrolateral shoulder and strongly projected on the venter, approaching to the keel with decreasing intensity. The secondary ribs are somewhat weaker than the primaries, running roughly parallel to the primaries. Some of them are nearly as long as the primaries; others are shorter, appearing at a point more or less upwards from the umbilical margin. The proportion in number of primaries and secondaries varies between individuals as well as between different growth-stages.

The umbilical tubercles, which are situated at or somewhat above the umbilical shoulder, are typically bullate but may be sometimes nodate. They are fairly distinct on the primary ribs but are very faint or imperceptible on the long secondaries. Every rib in the middle growth-stage has double ventrolateral tubercles, the inner one being more prominent than the outer; the former is nodate or spinose and the latter obliquely elongate adoral of the former on the ventral rib. On the probably adult body-whorl, on which ribs are distant, the inner ventrolateral tubercles are spinose, the spines extend laterally and are septate at the nodate base; the outer ventrolateral tubercles are reduced or united with the larger inner ones.

The suture is fairly similar to that of *Collignoniceras woollgari*, but the saddle between E and L is somewhat asymmetric, with the outer foliole higher and larger than the inner. L is deep, moderately broad and roughly bifid at its end.

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B/H	P. B. W. / R. B. W.	P. S. W. / R. S. W.	U. T. / V. T.
GK. H5432	41.2	12.0(0.29)	18.5	15.0	0.81	11/15	9/29	18/29
GK. H5431	17.5	6.0(0.34)	7.0	4.6	0.66	—	9/20	11/20
GK. H5433	22.3	r. 6.8(0.30) l. 6.4(0.28)	9.4	6.5	0.69	—	8/38	18/38
GK. H5480	20.0	6.2(0.31)	7.8	7.0	0.89	6/8	11/24	16/24

$\frac{\text{P. B. W.}}{\text{R. B. W.}}=\frac{\text{Number of primaries}}{\text{Number of ribs}}$ on the body whorl (within a half volution)

$\frac{\text{P. S. W.}}{\text{R. S. W.}}=\frac{\text{Number of primaries}}{\text{Number of ribs}}$ on a septate whorl preceding to the body-whorl

$\frac{\text{U. T.}}{\text{V. T.}}=\frac{\text{Number of umbilical tubercles}}{\text{Number of ventral tubercles}}$ ditto

Variation.—Specimens from one and the same locality are not identical in detailed characters. The above measurements may show the extent of variation in some respects and further explanations are given below for several representative specimens.

The holotype, GK. H5432 (Pl. 4, Fig. 1), represents the mean of the variation and the specific diagnosis is well shown by it.

One of the paratypes, GK. H5480 (Pl. 4, Fig. 2), has somewhat broader whorls, less numerous and more widely separated, coarser ribs than the holotype. The primary ribs are strong, rigid and nearly rectiradiate on the outer whorl. In this specimen the difference in length and strength of the ribs in three orders is more remarkable than in others.

Another paratype, GK. H5433 (Pl. 4, Fig. 3), has, on the contrary, more compressed whorls and more numerous and crowded ribs than the holotype. The ribs on its septate whorl, preceding the crushed body-whorl, are separated by interspaces almost as narrow as the ribs themselves but on earlier whorls they are separated by narrow interspaces. They are nearly equally long but of unequal intensity, although the difference in three orders is not great.

Another specimen, GK. H5431 (Pl. 4, Fig. 4), is nearly as compressed as GK. H5433, but has a wider umbilicus and less numerous and more distant ribs. The ribs of this specimen are, therefore, fairly similar to those of GK. H5480, but they are somewhat flattened on the flank between the umbilical and ventrolateral tubercles. The outer and inner ventrolateral tubercles on this specimen are approximated to form a doubling on a common basal node. An unillustrated specimen, GK. H5478, is also compressed and similarly ornamented, but is somewhat larger and has the crushed body whorl on which the ventrolateral tubercles are single and spinose. On these compressed but sparsely costate and spinose specimens the furrows on both sides of the keel are very shallow or almost imperceptible.

Although the characters are considerably dissimilar between the extreme variants, they are connected by intermediate forms, have essential points in common, and occur in the same bed. Therefore, they are regarded as specifically identical. This species is, thus, highly variable like the better known species of *Prionocyclus*.

Affinities.—The present species is considerably similar to *Prionocyclus reesidei* SIDWELL (1932, p. 318, pl. 49, figs. 10-12), from the Upper Turonian of the Western Interior province of the United States, in shell form and ornamentation. The former is, however, not so evolute as the latter and its ribs are not so rectiradiate. In *P. reesidei*, as in *P. quadratus* COBBAN, the incipient upper ventrolateral tubercles are developed on the outer whorl—the character which is not seen in the present species.

A comparatively broadly whorled variety of the present species, as represented by GK. H5480, resembles *Prionocyclus hyatti* (STANTON, 1894, p. 176, pl. 42. figs. 5-8) in the broad whorl, simple ribs of unequal strength, presence of outer ventrolateral tubercles and spinose ventrolateral tubercles. On the average the present species is more compressed, more involute and much smaller and has finer and more flexuous ribs of less irregularity than the latter. Certain immature specimens of the present species (as represented by GK. H5433 described above) are, like those of *P. hyatti*, closely allied to those of *Collignoniceras woollgari*, but is distinguished by the finely serrate keel on which the serration is more numerous than the ribbing.

Presumably the present species is a descendant of *C. woollgari* in Japan, being in parallel relationship with *P. hyatti*-*P. reesidei* in North America.

The present species is considerably different from *Prionocyclus wyomingensis*, the type-species of *Prionocyclus*. The former has simplc ribs on each of which both the inner and outer ventrolateral tubercles are well developed in the middle growth-stage, while the latter has often branching irregular ribs on which the outer ventrolateral tubercles are infrequently developed and even the inner ventrolateral tubercles are irregularly disposed in the middle growth-stage. The present species is less compressed and much smaller than *P. wyomingensis*. The two species are generally similar in the adult shell-form and ornamentation, although much different in size. They have also a finely serrated keel and a similar pattern of suture. Although the present species is not directly connected with *P. wyomingensis*, it is best referable to *Prionocyclus* as is *P. reesidei*.

Occurrence.—Loc. Ik 2012c, a small gully on the right side of the Pombets, close to the entrance of an abandoned colliery called "Ponbetsu Mansei-shako." The examined specimens occurred in calcareous nodules contained in the 15 m thick, dark grey, fine sandy siltstone, about 10 m below the green sandstone bed, lower part of the Upper Yezo Group on the western wing of the Ikushumbets anticline. *Inoceramus tenuistriatus* and *Inoceramus teshioensis* are associated with the present species. The fossiliferous bed can be assigned to the uppermost part of the Upper Gyliakian, because *Reesidites minimus* was found at loc. Ik 2013a immediately below this bed. It may be correlated with the Upper Turonian, possibly near the top of the Turonian.

The gully of Ik 2012 has been modified by subsequent erosion and vegetation and it is at present rather difficult to obtain this species from the same locality. The species should be searched for on other exposures of the same bed.

Prionocyclus aberrans sp. nov.

Pl. 5, Fig. 1; Pl. 6, Fig. 3; Text-figs. 8, 9

Material.—Holotype: GH. 12006 (Pl. 5, Fig. 1), a specimen in the collection of Hokkaido University, which was found by Mr. GOTO from a locality close to an abandoned colliery called "Ponbetsu Mansei-shako" and presented through Dr. Rinji SAITO to the University. Paratype (Pl. 6, Fig. 3): IGPS. 54757, from the Mikasa Endless, Ponbetsu coal-mine. The mode of preservation is similar in the two specimens in which the test is partly preserved.

Diagnosis.—The shell is of moderate size. It consists of rather slowly growing, evolute whorls and is moderately widely umbilicate. The outer whorl is slightly higher than broad and the inner one slightly broader than high. They are subquadrate in cross-section, with nearly parallel flanks, subangular umbilical shoulders, a steep umbilical wall and a roughly flat or very gently arched venter. The keel on the mid-venter is distinct, bordered by faint grooves, and finely serrate, but it may look entire on the internal mould.

The young whorl of the diameters from 5 to 15 mm. has simple ribs which are somewhat prorsiradiate. The umbilical bullae and spinose ventrolateral tubercles are discernible in lateral view.

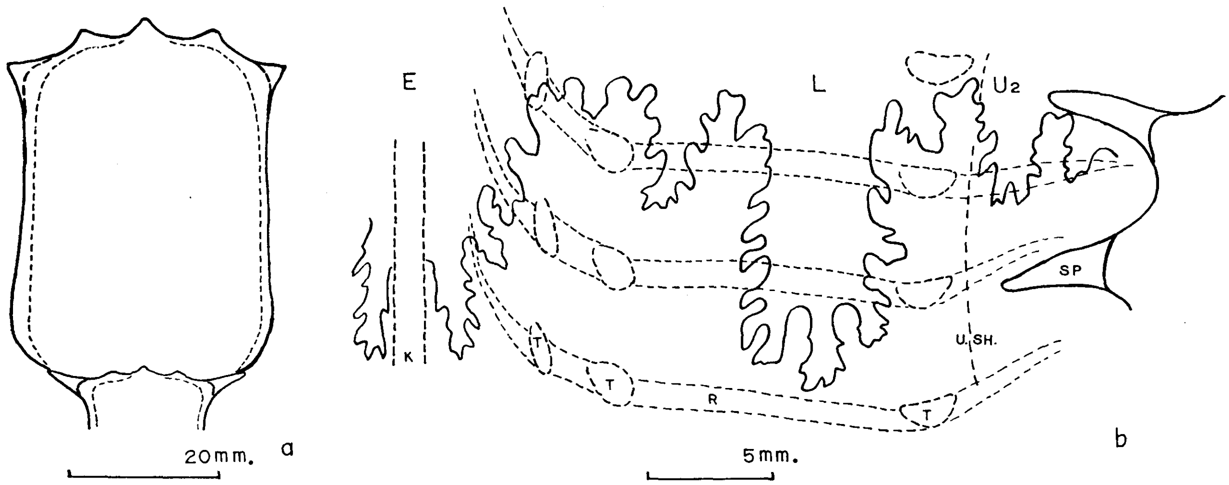


Fig. 8. *Prionocyclus aberrans* n. sp. Holotype, GH. 12006, from Pombets. (a) Cross section of the body-whorl and a part of the inner whorl; (b) external suture at whorl-height=20 mm., about a half whorl earlier than the last suture. Dotted lines show disposition of the keel (K), ribs (R), tubercles (T) and umbilical shoulder (U. SH.) in relation to the suture. Ventrolateral spines (SP) on the inner whorl is septate at the base. (T. M. *delin.*)

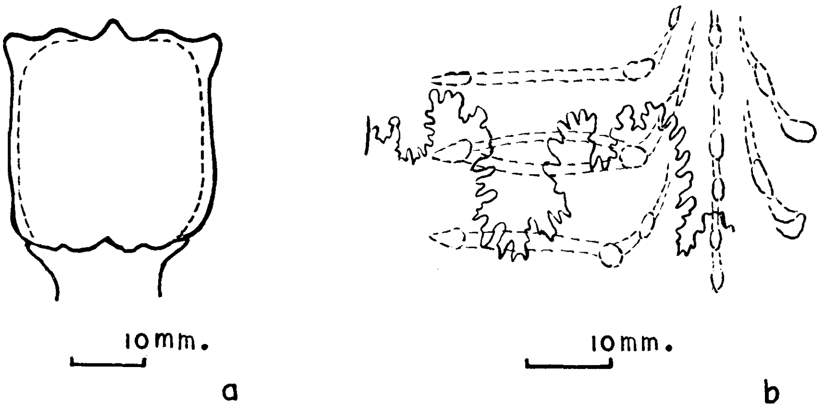


Fig. 9. *Prionocyclus aberrans* n. sp. Paratype, IGPS. 54757, from Pombets. (a) Whorl-section along the last septum; (b) external suture slightly posterior to the last suture. (T. M. *delin.*)

The ribs on the septate whorls, with diameters from about 15 mm. to 55 mm. in the holotype and to 70 mm. in the paratype, are simple, mostly rigid and strong, rectiradiate on the umbilical wall and on the flank, strongly bent at the ventrolateral shoulder and projected more and more as they approach the ventral keel. They are separated by interspaces somewhat wider than the ribs themselves. Each of them is provided with a considerably prominent tubercle at or slightly above the umbilical shoulder, a very strong and highly spinose tubercle at the ventrolateral shoulder and another smaller but distinct tubercle at a point somewhat adoral of the ventrolateral one. The spine, when well preserved, is pressed against the umbilical wall of the outer whorl. A finer, simple rib may be rarely discernible on some of the interspaces.

The outer whorl, which is half occupied by the body-chamber in the holotype, has numerous simple ribs which are more or less weaker than the rigid ribs on the preceding whorl described above. They are somewhat irregular in length, strength and curvature. The primary rib starts at the umbilical margin with a backward inclination, bent at the umbilical shoulder, nearly rectiradiate or slightly prorsiradiate or gently flexiradiate on the flank, bent at the ventrolateral shoulder and strongly projected on the venter. Some of the secondary ribs are nearly as long as the primaries; others are shorter, appearing at some distance above the umbilical margin. The secondaries are somewhat weaker than the primaries, especially on the lower part of the flank, running roughly parallel to the primaries. The disposition of the primary and secondary ribs is rather irregular; in some part they are alternated, in other parts two secondaries are intercalated between the primaries. Some of the secondaries may form a loop at the ventrolateral tubercle with the primary rib as seen on the paratype. The ribs on the last whorl are more or less weakened on the main part of the flank and are separated by interspaces somewhat broader than the ribs or in some parts nearly as broad as the ribs.

On the last whorl the umbilical tubercles are bullate and mostly rather depressed but a few of them are still pointed. The ventrolateral tubercles are prominent and spinose but do not form exaggerated horns. The ventral tubercles, some of which are clavate, are distinctly separated from and situated adoral of the ventrolateral ones at some distance. This character is more distinct on the preserved last part of the holotype than on the preceding part. In the paratype some of the outer tubercles are less elevated than in the holotype.

The suture is rather reduced, having comparatively shallow, minor incisions even in the adult stage. L is nearly as deep as E, moderately broad and asymmetrically trifid at the bottom. The saddle between E and L is broad, massive and asymmetrically divided, with the outer subdivision much broader than the inner. U_2 is much smaller than L as in many other collignoniceratids, and situated inside the umbilical shoulder.

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth
GH. 12006	119.0(1)	48.9(0.41)	40.5(0.34)	35.5(0.30)
〃 (last septum)	78.0(1)	31.3(0.40)	28.5(0.36)	27.0(0.34)
〃 (1 vol. early)	54.0(1)	20.8(0.38)	19.8(0.36)	21.2(0.39)
IGPS. 54757 (last septum)	78.0(1)	28.6(0.37)	30.7(0.39)	29.9(0.38)
〃 (1/4 vol. early)	61.0	23.6(0.38)	26.2(0.43)	23.6(0.39)
〃 (〃) (left side)	〃	22.2(0.36)		
〃 (3/4 vol. early)	35.2(1)	13.6(0.38)	14.4(0.41)	15.9(0.45)

Variation.—The present species is established only on two specimens, although they are fairly well preserved. The extent of variation, therefore, cannot be precisely described at present. The last suture is seen at the diameter of 78 mm. in both the holo- and para-types. The body-chamber is preserved for a half whorl in the holotype and is so for less than a quarter whorl in the paratype. The distant rigid ribbing of the middle growth-stage type is developed up to a diameter of 55 mm., i. e. a half volution before the last whorl, in the holotype, but it persists up to a diameter of 70 mm., i. e. fairly close to the last septum, in the paratype.

The paratype is unusual in that it shows inequilateral disposition of the ornaments on the outer whorl. The disorder seems to have arisen from the occasional looping of the ribs at uncorresponding positions on the two sides.

The umbilicus, in proportion to the shell diameter, seems to be slightly wider in the holotype than in the paratype, but this may be due partly to the change (enlargement) with growth (see *Measurements*). In the paratype the width of umbilicus is estimated at slightly different values between left and right sides of the shell.

Affinities.—This species is very like *Prionocyclus cobbani* described above. As *P. cobbani* is variable and as the type localities of the two species are regarded to be very close, if not identical, to each other, I considered the possibility that the present specimen (GH. 12006) could be an extreme variant of *P. cobbani* or that it might represent a sexual difference from the already described specimens of *P. cobbani*. The latter possibility is, however, less probable, because the difference is recognized already in the immature stage.

The species under consideration is indeed similar in some respects to a comparatively broadly whorled and strongly ribbed example of *P. cobbani*, as represented by GK. H5480, but there is still a significant gap between them. So I regard it as new, although it is represented only by two specimens. The main distinction may be written as follows. In the present species the shell is much larger, consisting of more evolute whorls, which is broader and has in the immature stage more rigid, more distant and stronger ribs, and also stronger tubercles than in *P. cobbani*. This species is especially peculiar in that the septate whorl has stronger and more distant ribs, with much fewer intercalation of secondaries, and more prominent ventrolateral spines than the adult body-whorl and that on the adult whorl the ribs are rather irregular in length and strength and the outer and inner ventrolateral tubercles are distinctly separated. The last character is not seen on the body-whorl of the normal species of *Prionocyclus*, where ventrolateral tubercles are reduced or united to the horn-like inner ventrolateral tubercles. In other words the characters in the adult whorl of the described specimen rather resemble those of the immature whorl of other species and those in the septate whorls of the former resemble in some respects those of the adult whorl of other species.

The paratype, in the collection of the Tohoku University, has an old label on which the specific name is written as *Gauthiericeras shibatai*. The same specific name was listed by SHIMIZU (1934, p. 74; 1935, p. 197), without describing diagnosis and distinction from the known species. It is evidently a *nomen nudum*. If the label were correctly placed, SHIMIZU's assignment of this specimen to *Gauthiericeras* would be criticized as incorrect. It is, however, interesting to note that some of the ribs on the outer whorl of this specimen show faint elevation at the mid-flank. The elevation is never so distinct as in *Prionocyclus quadratus* COBBAN, which foreshadows a character of *Gauthiericeras*, and many other ribs are free from such a incipient lateral tubercle. The persistency of the outer ventrolateral tubercles is a diagnostic feature of this species, which is quite distinct from *P. quadratus* in this and other respects. This character might be regarded as characteristic enough to separate this species as a new subgenus of *Prionocyclus*. As I am dealing with only two specimens by which the true extent of variation is hardly known, I would not dare to establish new subgenus on this occasion.

In the persistence of the outer and inner ventrolateral tubercles and simple ribbing the present species is apparently similar to *Subprionocyclus branneri* (ANDERSON) (1902) or *S. cristatum* (BILLINGHURST) (1927), but in *Subprionocyclus* the serration of the keel is large, corresponding in number to the ribbing, the ribs form chevrons on the venter, and the outer ventrolateral tubercles are more prominent and more persistent than the inner ventrolateral ones on the adult whorl.

Occurrence.—According to the information kindly given by Dr. R. SAITO, the holotype of this species came from a calcareous nodules in the dark coloured, very fine-sandy siltstone exposed near the entrance of an abandoned colliery called "Ponbetsu Mansei-shako." The lithology of the matrix is very similar to that of the rock exposed at loc. Ik 2012 and Ik 2013, which are close to that abandoned colliery. Therefore the specimen is regarded to have come from the rock belonging to the zone of *Inoceramus teshioensis-I. tenuistriatus*, although I cannot confirm whether the stratigraphic position of this species is precisely identical with or slightly lower than, that of *Prionocyclus cobbani*.

According to the locality record on the label, the paratype occurred at the Mikasa Endless of the Pombets Coal Mine which is close to Ponbetsu Mansei-shako. It was in a same nodule as numerous specimens of *Lymaniceras planulatum* (to be described below) and *Inoceramus tenuistriatus*.

Genus ***Lymaniceras*** nov.

Etymology.—To commemorate Benjamin Smith LYMAN, who was a pioneer in the geological reconnaissance of Hokkaido.

Type-species.—*Lymaniceras planulatum* sp. nov., to be described below.

Diagnosis.—The shell is rather small and thinly discoid, consisting of moderately involute, fairly rapidly growing, compressed whorls. The whorl is much higher than broad, with a low umbilical wall, flattened flanks, sloping ventrolateral shoulders and fastigate venter, which is provided with a finely crenate, narrow keel on the siphonal line. The umbilicus is moderately open.

The ribs are regularly long and short. They are prorsiradiate, sometimes gently flexuous, on the flank, and strongly projected on the venter to fade away as they approach the keel. Each rib has a small ventrolateral tubercle at the shoulder. The long ribs start from the umbilical bullae which are fairly prominent at the umbilical shoulder. The ribs are weakened and flattened on the outer whorl.

The suture consists of E, L, U_2, U_3 [=S], U_1, and I, as in other collignoniceratids. Minor incisions are rather simple, small and shallow, while folioles may be slightly phylloid. L, which is situated at about the middle of the flank, is narrowly V-shaped in a rough outline. The saddles on both sides of L are massive.

Affinities.—This new genus is allied to *Prionocyclus* in many respects, but is distinguished from that genus by its smaller size, greater involution of whorls, narrower umbilicus, sloping, instead of angular, shoulders, fastigate, instead of flat or gently arched, venter, more regular disposition of ribs, smaller and more regular ventrolateral tubercles and weaker ribbing and tuberculation on the outer whorls. The outer and inner ventrolateral tubercles are distinguished at least on the inner whorls of *Prionocyclus*, although the character appears more or less distinctly depending on species and also growth-stages. In the present genus the doubling of the ventrolateral tubercles is scarcely discernible, except for indistinct reminiscence of the feature in a limited period of a few young shells. Strong ornamentation, consisting of coarse ribs and exaggerated nodes, is characteristic of the outer whorls in normal species of *Prionocyclus*, whereas in the present genus ribs and tubercles are rather weakened on the outer whorl and the hypernodosity is never developed at any stage.

There is considerable plasticity in *Prionocyclus* and thus, *P. macombi* MEEK, which is an abnormal species of that genus, has somewhat intermediate features between *Prionocyclus* and *Lymaniceras*. (See also the discussion in the description of *L. planulatum* below.) To sum up *Lymaniceras* is probably derived from *Prionocyclus*, representing an offshoot in the subfamily Collignoniceratinae.

In the material available at present there is no example of *Lymaniceras* besides the type-species. Therefore it is not certain whether *Lymaniceras* gave rise to other genera or this offshoot was short and deadend. It cannot be, however, overlooked that this genus resembles *Pseudobarroisiceras* SHIMIZU, 1932, a Senonian genus, and *Pseudoschloenbachia* SPATH, 1921, an Upper Santonian-Lower Campanian genus. The two genera have a smooth, instead of finely serrate, keel, more involute whorls, on the average narrower umbilicus, and less distinct ventrolateral tubercles than *Lymaniceras*. The suture of *Pseudobarroisiceras* is similar to that of *Lymaniceras* but has more auxiliaries. That of *Pseudoschloenbachia* has still more numerous auxiliaries and more complex and deeper incisions than that of *Pseudobarroisiceras*. *Pseudoschloenbachia* has more distinctly fastigate venter and more falcoid ribs than *Lymaniceras* and *Pseudobarroisiceras*. On the grounds of above comparisons and also stratigraphic occurrence, I would suggest, as a possible line of descent, that *Pseudoschloenbachia* might have originated from *Lymaniceras* by way of such a genus as *Pseudobarroisiceras*, but more sufficient evidence is needed for a definite conclusion.

Lymaniceras is similar to *Reesidites* WRIGHT and MATSUMOTO, 1954, but the latter has a distinctly serrate keel, on which the serrations correspond in number with the ribs, and distinct marginal clavi which originate from the outer ventrolateral tubercles of *Subprionocyclus*. The serrations on the keel of *Lymaniceras* are more numerous than the ribs and the marginal tubercles in *Lymaniceras* are derived from inner ventrolateral tubercles of *Prionocyclus*.

Lymaniceras is also somewhat similar to *Niceforoceras* BASSE, 1948, a genus occurring commonly in the Coniacian of Colombia, but the former has less involute whorls and a wider umbilicus than the latter. The siphonal keel is distinctly and finely serrated in *Lymaniceras* just as in *Prionocyclus*, but in *Niceforoceras* it is nearly entire or has subdued serrations which corresponds in number with the ribs. While

Lymaniceras is derived from *Prionocyclus*, *Niceforoceras* seems to have been derived from *Subprionocyclus*, directly or by way of *Reesidites*, with greater involution of whorls, reducing of inner ventrolateral tubercles, weakening of ribs and smoothing of a keel. *Niceforoceras* probably gave rise to *Paralenticeras* HYATT, 1903, and other members of true Lenticeratinae, as was discussed by REYMENT (1958). To sum up, a line of descent *Prionocyclus-Lymaniceras-Pseudoschloenbachia* may be, in my opinion, in parallel relationship with that of *Subprionocyclus-Niceforoceras-Paralenticeras*.

Lymaniceras somewhat resembles compressed, atypical species of *Prionocycloceras*, but the former has moderately involute whorls, a fastigate, instead of squarish, venter, small and never exaggerated ventrolateral tubercles, and its keel is not so clearly crossed by the extensions of the ribs and lirae as in the latter.

It is interesting to note in this connection that *Lymaniceras* is apparently similar to *Amaltheus* of the Jurassic family Amaltheidae, just as *Prionocycloceras* is so to *Pleuroceras* of the same family. These are evidently examples of heterochronous homoeomorphy.

Distribution.—So far as the available material is concerned, *Lymaniceras* is represented by a single species occurring in a limited area of central Hokkaido. Its stratigraphic position is the zone of *Inoceramus teshioensis-Inoceramus tenuistriatus* in the upper part of Upper Gyliakian, approximately Upper Turonian.

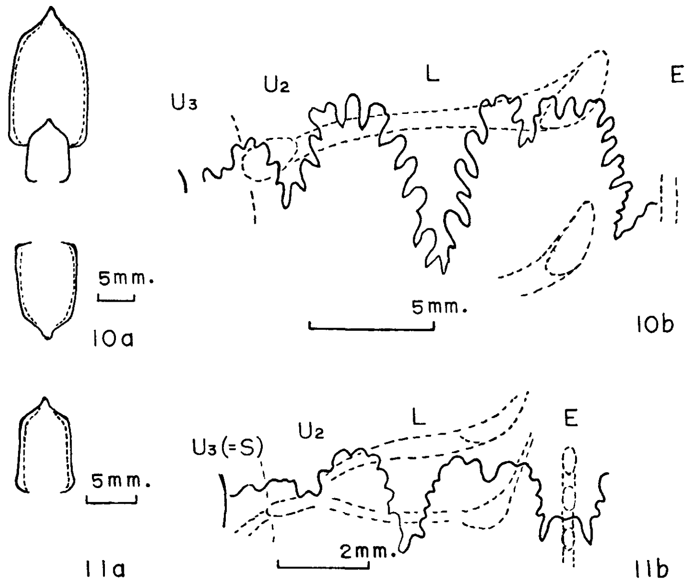
Lymaniceras planulatum sp. nov.

Pl. 6, Figs. 1-2; Pl. 7, Figs. 1-5; Pl. 8, Figs. 1-8; Text-figs. 10-16

Material.—Holotype. GK. H5430, from loc. Ik 2012c, a small gully on the right side of the Pombets [=Ponbetsu], a tributary of the Ikushumbets, Hokkaido, extracted from a calcareous nodule in the dark fine-sandy siltstone of the Upper Yezo Group, IIIa′, zone of *Inoceramus teshioensis-I. tenuistriatus* (Coll. T. MURAMOTO, no. 575). It consists mainly of the septate whorl and only a posterior portion of the body-whorl is preserved. More than fifteen specimens from the type-locality, of which the illustrated paratypes are GK. H5427, H5429a, H5465, H5466, H5467a, b, H5468, H5472, H5474, H5475, H5476 (Coll. T. & K. MURAMOTO and T. MATSUMOTO), and also GK. H5527 and GK. H5528 (Coll. K. TANAKA).

GK. H5526, from loc. B218, and GK. H5527a-e, from loc. B223, both in the upper reaches of the Bibai, bed Uw_1 of the Ashibetsu sheet (Coll. K. TANAKA). In addition to the specimens in the collections of Kyushu University, I have examined another fairly well preserved one in those of Hokkaido University, which was obtained, according to the available locality record, "a cliff along the Pombets, near Manseishako", an abandoned colliery close to loc. Ik 2012. Also IGPS. 36834, from "Pombets coal-mine" (Coll. S. SHIMIZU), IGPS. 56892 (A, B, C and other numerous specimens), from "Mikasa Endless, Pombets coal-mine" and IGPS. 72832, from the Bibai river, in the collection of Tohoku University are examples of the present species. There are several specimens in the collection of the Mikasa High School, Mikasa City, Hokkaido.

Diagnosis.—The shell is thinly discoid and rather small, about 40 mm. in diameter



Figs. 10, 11. *Lymaniceras planulatum* sp. nov. Holotype (10), GK. H5430, and a paratype (11), GK. H5474, from Pombets. (a) Whorl-section; (b) external sutures at whorl-height=17 mm (10b) and that of 7 mm (11b). (T. M. *delin.*)

at the last septum of the holotype, consisting of moderately involute whorls. The whorl is compressed in the main growth-stages. The holotype, for instance, has the proportion of about 10 : 6 between height and breadth in its outer whorl. The umbilicus is shallow, moderately open, occupying about 30 percent of the diameter of the shell, surrounded by the low but steeply inclined wall. The umbilical shoulder is subangular in the costal section but sloping in the intercostal section. The flanks are flattened or slightly inflated, broadest in the lower part or between umbilical bullae, and gently convergent upwards, passing to the fastigate venter with a subangular to sloping ventrolateral shoulders.

The keel on the siphonal line is narrow, distinct, and finely serrate on the test but may look entire on the internal mould. The serrations are more numerous than the ribs.

The ribs, which begin to appear at the shell diameter of about 5 mm., consist of primaries and secondaries. The two kinds of ribs are alternated in some parts and two secondaries are intercalated between the primaries in other parts. The ribs are mostly simple, but occassionally the secondary rib may be so close to the lower part of the primary rib that they appear to branch.

The primary ribs have bullate umbilical tubercles, which are fairly strongly nodate at the umbilical shoulder in the middle growth-stage, but may be weakened on the outer whorl. The ribs are prorsiradiate, sometimes gently flexuous, on the flank, bent at the ventrolateral shoulder, and projected on the venter. Each rib has a small but distinct ventrolateral tubercle, from which the elevation is extended obliquely forward with decreasing strength. There is almost no perceptible doubling of the tubercle. The umbilical tubercles are comparatively more distant and less numerous on the inner whorl than on the outer. The ventrolateral tubercles are rather crowded. On the outer whorl the ribs tend to be weakened and flattened and in some specimens they are fine and numerous and the flank is almost laevigate. On the inner layer of the well preserved shell of the holotype a fine feather structure is partly discernible.

The suture consists of E, L, U_2, U_3 [=S], U_1, and I. The external lobe (E) is moderately deep and broad; the first lateral lobe (L) is the deepest, narrowly triangular in a rough outline, and situated at about the middle of the flank; the second lateral lobe (U_2) is much smaller than L and situated slightly above the umbilical shoulder; subdivision of U_3 is not numerous. The saddle between E and L is broad, massive, and asymmetrically and shallowly bipartite. The sutual elements are not deeply incised and less complex. The folioles are rather simple, small, and somewhat phylloid in aspect.

Measurements.—

Specimen	Diameter	Umbilicus	Height*	Breadth*	B./H.	U. T./VL. T. **
GK. H5432	42.0	12.6(0.30)	18.4	11.3	0.61	12/30
〃 (−1/4 vol.)	34.6	9.6(0.28)	15.2	9.1	0.59	11/24
GK. H5474	22.6	7.0(0.31)	9.4	6.2	0.66	10/25
GK. H5465	13.1	4.0(0.30)	5.8	4.0	0.68	11/22
GK. H5466	18.7	5.8(0.31)	7.5	5.2	0.66	11/30
GK. H5467b	10.4	3.2(0.31)	4.4	2.8	0.63	—
GK. H5476	21.6	6.5(0.30)	9.1	5.7	0.62	16/33
GK. H5528	44.4	13.2(0.30)	19.0	9.5(+)	0.5(+)	14/32
〃 (−1 vol.)	18.2	5.5(0.30)	7.7	4.5	0.56	
GK. H5472	32.0	9.7(0.30)	14.0	8.0	0.57	19/33***
〃 (−1/2 vol.)	—					9/18
IGPS. 36834	55.5	17.4(0.31)	23.7	15.5	0.65	—
IGPS. 56792	52.2	13.3(0.26)	22.7 (sec. compr.)			—
〃 (−1/4 vol.)	41.2	10.5(0.26)	19.4	11.0	0.57	11/24
HK. —	54	17 (0.3)	20	12	0.6	20/33(?)

* The height of the whorl includes that of the keel and the breadth of the whorl includes that of the costae.

** U. T.=number of umbilical tubercles, VL. T=number of ventrolateral tubercles in the measured whorl.

*** Those on the densely costate body-whorl are in part included.

Ontogeny.—Many specimens are sufficiently well preserved for the study of the ontogeny of the shell. The protoconch is very small, about 1/3 mm. in shorter diameter, only partly exposed and enveloped in the first whorl.

The first three whorls are rather evolute, slowly growing, much inflated, broader than high, smooth on the surface, without a keel, and provided with simple sutures with scarcely developed minor incisions.

Late in the third or early in the fourth whorl, at a diameter of about 4.5 mm., the siphonal keel and the umbilical bullae begin to appear, although they are at first faint. The ventrolateral nodes are almost imperceptible, but may be very faintly discernible under oblique light. The keel is already minutely serrate. The whorl

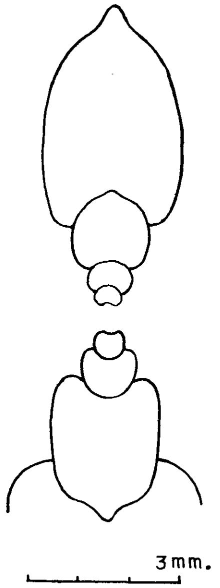


Fig. 12. *Lymaniceras planulatum* sp. nov. Cross section of an immature specimen, GK. H5467b, from loc. Ik2012c, showing the ontogenic change in whorl shape. (T. M. *delin.*)

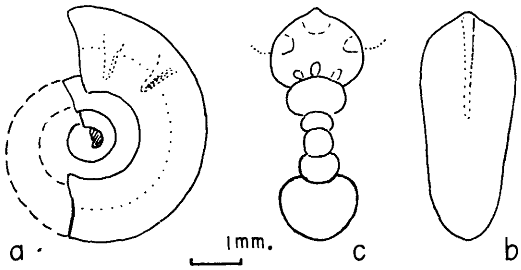


Fig. 13. *Lymaniceras planulatum* sp. nov. Inner nuclear part of GK. H5527, from loc. B223, Bibai. (a) Lateral and (b) ventral views; (c) cross section. (T. M. *delin.*)

section is roundish and then subquadrate with a tendency to have slightly inflated flanks, abruptly rounded ventrolateral shoulders and a gently arched venter.

In the succeeding stage, that is in part of the fourth whorl, remarkable changes take place in various respects. The whorl increases rapidly in height, becoming compressed and less evolute (embracing about one third or more of the inner whorl), the finely serrate keel becomes distinct, the umbilical bullae at the end of the primary ribs are strengthened, the ventrolateral tubercles on the primary and secondary ribs become considerably distinct, and the sutural elements have minor incisions. At first the ventrolateral shoulders are subangular and the whorl section is subrectangular, as in young *Prionocyclus*, but soon the flanks are somewhat convergent, the shoulders are sloping and the venter is characteristically fastigate.

After this rapidly changing stage the shell-form does not show a remarkable alteration, keeping fairly constant values in the width of the umbilicus in percentage of the entire shell diameter, in the degree of involution (about 3/7 to nearly 1/2), and in the proportion between height and breadth. A change occurs, however, in the ornament. In the middle growth-stage the ribs are more distant, less numerous and somewhat stronger and the umbilical and ventrolateral tubercles are more prominent than in the late growth-stages, although this change may take place at different diameters and to variable extent between individuals. On the adult body-whorl the ribs are weakened, fine and crowded and the tubercles are also weakened.

There is no great change in the fundamental pattern of the suture. The elements of E, L, U_2, U_3, U_1 and I are established very early in growth-stage. Minor incisions are somewhat, but not much, deepened and multiplied as the shell grows.

Variation.—This species is not very variable in shell-form. The width of the umbilicus, for instance, is normally about 30 percent of the shell and ranges in measured examples from 26 to 31 percent, except in the very young stage. The proportion of whorl breadth to height is likewise within a limited extent of variation, ranging from 5.6:10 to 6.8:10 except for the depressed to rounded whorls in the infant stage.

There is, however, a great variation in the ornamentation. The holotype has ornament of moderate intensity. A paratype in the collection of Hokkaido University, which is nearly as large as the holotype, has somewhat more numerous (see measurements) and more flattened ribs with more distinct lirae than the holotype. GK. H5528 and IGPS. 56892A (Pl. 6, Fig. 1), paratypes with similar dimensions, have still weaker, finer, and more numerous ribs and also weaker tubercles on the adult body-whorl. On its inner whorls the ribs are nearly as distant as those of the holotype, but they are somewhat weaker. GK. H5472 (Pl. 8, Fig. 8) and GK. H5526 may represent an extremely weakly ornamented variety, in which ribs and tubercles on the outer whorl are so faint, fine, and numerous that the surface looks almost smooth, the crenulation of the keel is also weakened and the umbilical bullae and ventrolateral tubercles remain as faint elevations. On the inner whorls this variety has also weak ribs, but its umbilical tubercles are as distant as those in the normal examples.

Smaller specimens before me, which are probably immature shells, likewise show a considerable extent of variation in the intensity and density of the ribbing and tuberculation. GK. H5474 (Pl. 7, Fig. 5) represents, for instance, a moderately strongly ornate example, in which the ribs, consisting of 10 primaries and 15 secondaries in the measured whorl, are separated by interspaces somewhat wider than the ribs themselves. GK. H5476 (Pl. 7, Fig. 4) has more crowded, more numerous, and finer ribs (16 primaries out of 33 ribs as compared with 10 primaries out of 25 ribs in

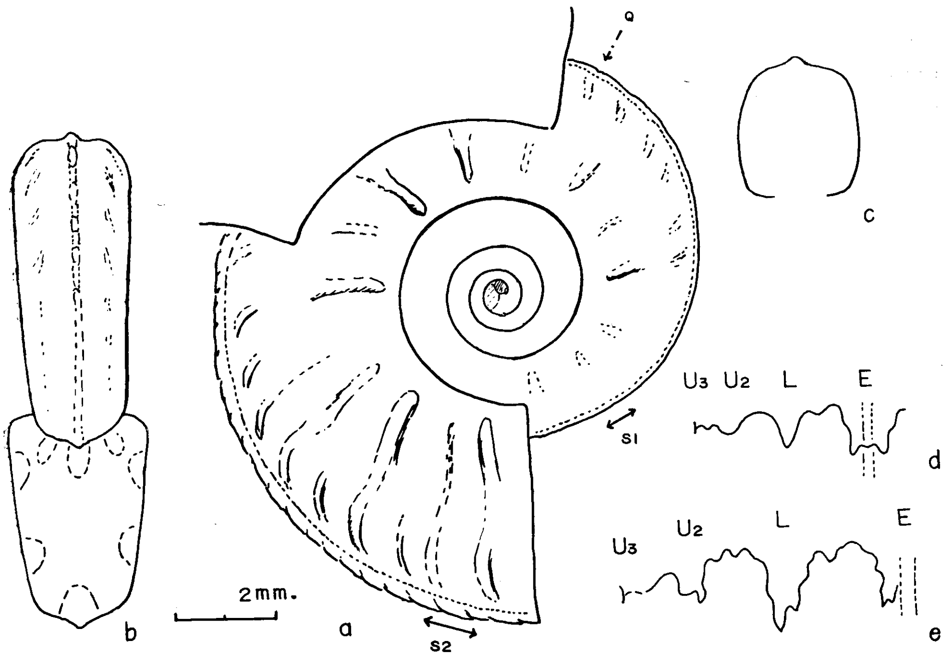
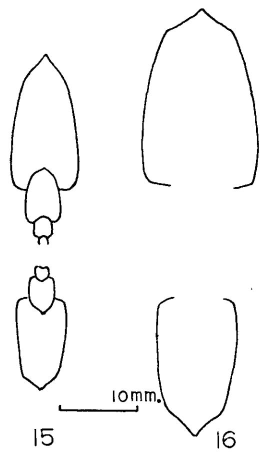


Fig. 14. *Lymaniceras planulatum* sp. nov. Early immature shell in the nuclear part of GK. H5429a, from loc. Ik2012c, Pombets. (a) Side view; (b) front view; (c) diagrammatic whorl section at Q of Fig. a; (d, e) external sutures at S_1 and S_2 in Fig. a. (T. M. *delin.*)



Figs. 15, 16. *Lymaniceras planulatum* sp. nov.
15. Whorl-section of a compressed variety, GK. H5528, from loc. Iw605, Pombets.
16. Whorl-section of a normal example, IGPS. 36834, from Pombets.
(T. M. *delin.*)

GK. H5474) than the preceding specimen. GK. H5468 (Pl. 8, Fig. 7) has still finer and more numerous ribs (20 primaries out of 36 ribs) and weaker tubercles at the shell diameter of a similarly small dimension. In this and other finely ribbed specimens the ribs on the outer whorl rather irregularly vary in density and fineness from parts to parts.

The ventrolateral tubercles are single in most specimens, but in a few examples, e. g. in GK. H5527, they are indistinctly double in a limited part of the young whorl (with height of about 5 mm.), although the outer ventrolateral elevation is vary faint. Likewise, the siphonal keel may be accompanied by very shallow furrows on the venter of a few young shells, but the furrows are imperceptible in many others.

The subrectangular whorl section, with subangular ventrolateral shoulders, like that of *Prionocyclus*, can be seen in a young stage at various grades of distinctness among different individuals and the characteristic fastigate venter appears more or less late in the growth-stage.

The difference between extreme examples as mentioned above, especially with regards to the ornamentation, might be accounted by someone as a specific distinction. They are, however, connected by intermediate examples and various specimens occur in the same bed exposed at one and the same locality, and sometimes even in the same nodule. Moreover the variation in shell-form is rather little, as explained above. Therefore I would regard these various examples as representing the variation within a species.

The variation in size is not precisely estimated from the available material. The holotype is about 40 mm. in diameter at the last septum. If its body-whorl were completely preserved, the shell would reach about 80 mm. A fragmentary body-whorl of another individual, GK. H5475 (Pl. 8, Fig. 5), also suggests approximately this order of size. The last suture of a rather weakly ornamented example, GK. H5528, is at a diameter of about 37 mm., which is not much different from that of the holotype. Another specimen, GK. H5472, has the last suture at a diameter of 30 mm., the dimension smaller than the above examples. This can however, be regarded as adult, because the last septa are approximated and the ornament is much weakened on the body-whorl.

A much smaller specimen, GK. H5474, has somewhat approximated last two sutures at a diameter slightly below 20 mm., but I would not assume it to be full-grown, because the ornament is of the adolescent type. The distance of septa could deviate from a regular disposition even in the immature stage.

It is very difficult to know whether this species shows such a sexual dimorphism as that exemplified by *Hecticoceras* and *Quenstedtoceras* (see MAKOWSKI, 1962), but no analogous feature has been confirmed.

Remarks.—IGPS. 36834 was labelled as *Prionocyclus imbecilluscostatus* SHIMIZU MS. This specific name is a *nomen nudum*, which SHIMIZU (1934, p. 75) listed without giving diagnosis nor clear distinction from the known species. The specimen (Pl. 6, Fig. 2; Text-fig. 16) is incompletely preserved, but it is identical with the holotype of the present new species (*Lymaniceras planulatum*).

Many specimens under a common register number, IGPS. 56892, and another specimen, IGPS. 72832, were labelled as *Prionocycloceras ezoense* SHIMIZU MS. This specific name is likewise a *nomen nudum*, which SHIMIZU (1935, p. 197) listed without definition. The specimens are mostly finely ribbed varieties of the present species.

SHIMIZU's assignments of these specimens to *Prionocyclus* and *Prionocycloceras* were inadequate and his age determination as Coniacian was also incorrect. (See occurrence below.)

Affinities.—The present species is closely allied to *Prionocyclus macombi* MEEK (1876, p. 132, pl. 2, figs. 3a-d; STANTON, 1894, p. 172, pl. 41, figs. 1-5), from the Upper Turonian of the Western Interior province of North America, in the discoidal shell, compressed whorls, shallow and moderately open umbilicus, finely crenate keel, disposition of the primary and secondary ribs, umbilical bullae and ventrolateral tubercles, and also in the general pattern of the suture. *P. macombi* has, however, a subrectangular whorl section, with a flat venter and subangular ventrolateral shoulders, and the prominent, sometimes spinose, ventrolateral tubercles on the whorls of the middle and late growth-stages. These characters are diagnostic of *Prionocyclus*. In the present species they are not kept; namely the venter is fastigate, the shoulders are sloping, ribs and tubercles are weakened in more or less late growth-stages. These are new characters particular to the present species. According to STANTON (1894), young inner whorls of *P. macombi* has numerous, dense, prorsiradiate simple ribs like those of other species of *Prionocyclus* and *Collignoniceras*. The present species has in the corresponding stage distant umbilical bullae and then alternating long and short ribs with strong umbilical bullae at the end of the long ribs. The ventrolateral tubercles in this species are small, usually simple, and never show exaggerated horns or spines.

As I have already remarked above (p. 20), *Prionocyclus macombi* MEEK is rather an atypical species of *Prionocyclus*. It has in some respects intermediate features between typical species of *Prionocyclus*, such as *P. wyomingensis* and *P. hyatti*, and the present species. In the geographical distribution the two species are much separated, although New Mexico, the type-locality of MEEK's species is, in my opinion, an important area in the interregional connection. There is no satisfactory evidence to confirm that the present species is somewhat younger than *P. macombi*, although it is likely so. We need, thus, more evidence to trace exactly the origin of the present species.

Gauthiericeras lenti GERHARDT (1897, p. 77, pl. 1, fig. 4a-b; text-fig. 3), from the Coniacian of Colombia-Venezuela, is somewhat similar to the present species in the compressed whorl, crenulated keel, general aspects of ornaments, etc. It is, however, distinguished from this species by a rather flat, instead of fastigate, venter, subangular, instead of sloping shoulders, more prominent ventrolateral tubercles, from which weak ribs are projected on the venter crossing the keel, and more evolute whorls. These characters indicate that GERHARDT's species is better referred to *Prionocycloceras* than to *Gauthiericeras*, as REYMENT (1958, p. 12) has already suggested.

For further comparison remarks have been given in the preceding pages (p. 30) in connection with the proposal of a new genus.

Occurrence.—Loc. Ik2012b and Ik2012c, a small gully on the right side of the Pombets [=Ponbetsu], a tributary of the Ikushumbets, Hokkaido. The species occurs, at Ik 2012c, in association with *Prionocyclus cobbani*, *Inoceramus tenuistriatus* and *Inoceramus teshioensis*. The specimen in the collection of Hokkaido University, labelled as "close to Mansei-shako, Pombets" and TANAKA's specimens, from his loc. Iw605, Pombets, seem to have come from the identical or very close place to Ik2012. TANAKA's loc. B218 and B223 in the upper reaches of the Bibai, Bed Uw_1 in his explanation to the geological map of "Kamiashibets" quadrangle.

All these occurrences are in calcareous nodules in the dark colored, fine-sandy siltstone belonging to the lower part of the Upper Yezo Group on the western wing of the Ikushumbets anticline. The bed is in the upper part of the zone of *Inoceramus tenuistriatus-I. teshioensis* and is referable to the uppermost part of the Upper Gyliakian. It may be correlated with the Upper Turonian, probably close to the Turonian-Coniacian boundary. The green sandstone immediately above this fossiliferous bed probably indicates the base of the Coniacian, because *Forresteria* sp., *Solgerites* sp., and *Baculites yokoyamai* occur in the green sandstone.

A few other examples of this species were collected by a student (Mr. KOBAYASHI) of Mikasa High School from the upper reaches of the Sentaro-zawa, a branch of the Ikushumbets, about 5 km. west of Pombets. They came from a calcarous nodule in fine-sandy siltstone together with *Prionocyclus* cf. *cobbani* and *Inoceramus tenuistriatus*.

A set of specimens of IGPS. 56892, in the collection of Tohoku University, was in the same nodule as the paratype of *Prionocyclus aberrans* n. sp., occurring with *Inoceramus tenuistriatus* from Mikasa Endless of Pombets coal-mine. IGPS. 36834 is simply recorded as Pombets coal-mine and IGPS. 72832 as the Bibai.

The sediments containing *Lymaniceras planulatum*, *Prionocyclus cobbani* and *P. aberrans* belong to those of the western facies of the Cretaceous basin of sedimentation in Hokkaido, which were probably under shallower sea and closer to the coast of a land in the west than the sediments of the central and eastern facies.

Genus *Prionocycloceras* SPATH, 1926

Type-species.—*Prionocyclus guayabanus* STEINMANN, *in* GERHARDT, 1897, by original designation.

Synonymy.—*Donjuaniceras* BASSE, 1950, as pointed out by WRIGHT *in* MOORE [Ed.] (1957, p. L429).

Generic diagnosis.—The full-grown shell may reach a large size. The whorls are evolute, subrectangular in section, with subangular or abruptly rounded ventrolateral and umbilical shoulders, nearly parallel flanks, and a gently arched or nearly flattened venter. The umbilicus is of moderate size and surrounded by a steeply inclined or nearly vertical wall.

The siphonal keel is distinct in the main, middle growth-stages, but may become low or even flattened on the large outer whorl. It is normally bordered by shallow grooves on both sides, and finely crenulated on its summit, being crossed by projected ventral riblets and lirae, but may sometimes look entire on the internal mould. The crenulations are more numerous than the ribs on the flank.

The ribs are generally simple, sometimes with intercalated secondaries, rather distant in the typical species, somewhat convex on the flank, showing a rursiradiate inclination as they approach the ventrolateral shoulder, provided with more or less strong tubercles at the shoulder, abruptly bent there, and running across the venter with a strongly projected curve and with thinning.

The ventrolateral tubercles may be double in certain growth-stages of some species, but the outer ones are weaker than the inner, or obsolete, or absorbed by the exaggerated, horn-like or spinose, inner ventrolateral tubercles. The horn or spine extends laterally or ventrolaterally and is septate near the base. The tubercles on the secondary ribs may be weak. They may change their prominence with growth. The tubercles at the umbilical end of the primary ribs are moderately strong or weak, and nodate or bullate.

The suture is rather simple, consisting of E, L, U_2, U_3 [=S], U_1 and I, with shallow and small minor incisions. The saddle between E and L is broad and massive. The sutural pattern is generally similar to that of *Collignoniceras* and *Gauthiericeras*.

Remarks.—Prionocycloceras was established by SPATH (1926, p. 80), with *Prionocyclus guayabanus* STEINMANN *in* GERHARDT as the type-species. SPATH did not give clearly its diagnosis, but considered it as "transitional between *Prionocyclus* and *Gauthiericeras*, with the keel tending to become continuous, as in the latter."

The keel may look entire in both *Prionocyclus* and *Prionocycloceras*, if internal moulds are considered. The two genera are very closely allied to each other. They have similarly evolute whorls, a subrectangular and more or less compressed whorl-section, a similar type of ornamentation, in which ventrolateral tubercles are typically spinose or horn-like in some growth-stages, and a finely crenate keel is usually bordered by shallow grooves. The distinction between them are in that the keel is crossed by moderately projected riblets and lirae on the venter of *Prionocycloceras*, while in *Prionocyclus* the ventral ribs are strongly projected to run away in parallel to the keel or to join the keel, without showing crossing. This feature may be again hardly observable on internal moulds.

Another distinction may be in that the ribs are rather irregular in strength and length and are usually dense and numerous on the inner whorls of *Prionocyclus*, but they are regular and rather distant in *Prionocycloceras*. They are prorsiradiate and sometimes concave on the flank in the former, but convex or nearly rectiradiate in the latter.

SPATH's keen insight in placing *Prionocycloceras* at an intermediate position between *Prionocyclus* and *Gauthiericeras* should be indeed appreciated in a general view, but the evidence is by no mean satisfactory. The diagnosis of *Gauthiericeras* DE GROSSOUVRE, 1894, is that it has well developed umbilical bullae, which are double on summit or have upward removed elevations, i. e. apparently median lateral tubercles, in addition to the umbilical bullae at least in certain growth-stages, and that the whorl section is consequently trapezoidal to subquadrate, besides the features already mentioned by previous authors. I would suggest that the tendency to have this character is seen in a certain subgroup of *Prionocyclus*, as represented by *P. quadratus* COBBAN. The ornamentation is more regular and better settled in *Gauthiericeras* than in that subgroup of *Prionocyclus*. According to WRIGHT *in* MOORE [Ed.] (1957, p. L429) and WIEDMANN (1959, p. 762), *Gauthiericeras* seems to have appeared already in Upper Turonian. For the above mentioned morphologic and stratigraphic reasons, I would consider, as another possibility, that *Gauthiericeras* could be derived directly from *Prionocyclus* and not by way of *Prionocycloceras*, although there is much to be done for tracing precisely one or the other suggested line of descent in two alternative views.

Anyhow, *Prionocycloceras* is more intimately related to *Prionocyclus* than to *Gauthiericeras*. Consequently I am inclined to transfer *Prionocycloceras* from the subfamily Peroniceratinae to the Collignoniceratinae. *Gauthiericeras* itself is to be kept in the Peroniceratinae and further remarks on that genus are to be given in the description of Peroniceratinae.

YOUNG (1963, p. 67) has recently described large adult shells of *Prionocycloceras guayabanum* in the late Professor W. S. ADKINS' collection from the type-locality, near Chejendé, Venezuela. Unfortunately his illustrations (YOUNG, 1963, pl. 23, figs. 5, 6; pl. 27, figs. 2, 3; text-figs. 12a, 14a, 33d) do not show clearly the relation between them and the small type-specimen illustrated by GERHARDT (1897, pl. 5, fig. 22a-c), but his reasoning is probable trustworthy. YOUNG (1963), furthermore, has shown several large specimens of the same genus from the Gulf Coast of the United States.

A large body-whorl occured also in Hokkaido but it is fragmentary. It shows, however, broad and low ribs and also lirae crossing a much depressed extension of mid-ventral keel with a projected curve (Pl. 10, Fig. 2).

In the description of Gulf Coast species YOUNG (1963) complained at length of the difficulty in distinguishing *Protexanites* from *Prionocycloceras*. The difficulty may indeed be ascribed to a similarity in some respects, but may be in parts due to the unfavourable condition that the Texas specimens are mostly internal moulds without preservation of shell-layers.

Prionocycloceras has in some case both inner and outer ventrolateral tubercles, but the outer ones are normally weaker than the inner, or even obsolete, and situated somewhat obliquely ahead of the inner ones, as is the case with many *Prionocyclus*. Its keel is crenated on the summit and crossed by the ventral riblets and lirae with a projected curvature, although this feature may be hardly discernible on internal moulds. *Protexanites* has always an inner and an outer ventrolateral tubercle on each rib, which may be rectiradiate or somewhat prorsiradiate on the flank but not so strongly projected on the venter as in *Prionocycloceras* and ends at the outer ventralateral tubercle, without crossing the grooves and the keel. The inner tubercles may be spinose in some species. This may give an apparent similarity between *Protexanites* and *Prionocycloceras*. The outer ventrolateral tubercles in *Protexanites* are distinct, clavate and fairly close to the smooth keel. To sum up, *Protexanites* is certainly derived from *Subprionocyclus*, in which outer ventrolateral clavi are more predominant than the inner nodes, while *Prionocycloceras* is most probably derived from *Prionocyclus* in which the inner ventrolateral tubercles are predominant and the outer ones tend to be reduced.

Judging from the above distinction, I consider that *Prionocycloceras hazzardi* YOUNG (1963, p. 71, pl. 24, fig. 4; pl. 25, figs. 2, 3; pl. 26, figs. 1, 2; pl. 27, fig. 4; pl. 34, fig. 2; pl. 39, fig. 3; text-figs. 12f, 13b, d, 14g. 20h), from the Upper Coniacian of Texas, might be a *Protexanites*, but I cannot state conclusively, without seeing specimens of various growth-stages. Similarly *Prionocycloceras gabrielense* YOUNG (1963, p. 69, pl. 24, figs. 1-3; pl. 29, fig. 5; pl. 67, fig. 1; text-fig. 21c) might be doubtful, but again I cannot be certain.

Now the specimens of *Prionocycloceras* from Hokkaido are not numerous and more or less imperfectly preserved. This gives some difficulty in identification or comparison with the previously described species. Of about a dozen species established by GERHARDT (1857), ANDERSON (1902, 1958), BASSE (1950), SORNAY (1957), and YOUNG (1963), very few species have been studied and described precisely about the changes with growth and also about the variation. One of the species from Japan described below shows a sudden and remarkable change in the ornamentation at a certain growth-stage. This fact warns against the hasty erection of a new species on the basis of small young shells alone or of large adult shells alone.

Prionocycloceras sigmoidale sp. nov.

Pl. 9, Fig. 1; Pl. 10, Figs. 1-2; Text-figs. 17, 18

Material.—Holotype, GK. H5435, from loc. 2001 of T. MURAMOTO, close to Ik1111 of MATSUMOTO, Ban-no-sawa, a left branch of the Ikushumbets, calcareous concretion in greenish dark grey, fine sandy siltstone, Member IIIb of MATSUMOTO (1959), zone of *Inoceramus uwajimensis* (Coll. T. MURAMOTO). Paratypes No. 108 and another collection of Mikasa High School, from Kami-ichi-no-sawa, a right tributary of the Ikushumbets. The holotype is wholly septate, while one of the paratypes (MHS. 108) is a fragmentary body-whorl and the other is a deformed, immature shell. They are all coated with dark green, chloritic matter.

Diagnosis.—The shell seems to attain a moderate size, with whorl-height of about 50 mm., and accordingly a diameter of 125 mm. at a rough estimation.

The whorls are evolute, the outer one overlapping only the ventral part of the inner. The umbilicus is moderately wide and is surrounded by a vertical wall. The whorl is higher than broad, with a proportion of breadth to height about 0.8 in costal section of late growth stages and slightly broader in young stages, subrectangular in cross section with flattened and nearly parallel flanks, subangular (in tuberculated young stage) to abruptly subrounded shoulders and a very gently arched venter.

The mid-ventral keel is considerably broad, bordered by shallow grooves, on the inner whorl fairly strong and minutely serrate, and on the outer whorl comparatively low and very faintly undulate or nearly entire.

The ornamentation of the shell changes rather abruptly at a diameter of about 35 mm. On the inner whorls there are fifteen ribs, which are rigid, nearly rectiradiate or slightly convex on the flank, simple, without secondaries, separated by broader interspaces and provided with moderately strong and somewhat bullate umbilical tubercles and very prominent, probably spinose, ventrolateral tubercles, from which ribs are abruptly projected with decreasing strength; very faint node-like elevations may be discernible on some ventral ribs under oblique lighting but they are almost obsolete on others.

On the outer whorl, at diameters over 35 mm., the ribs are gradually lowered, broadened, and more crowded as the whorl grows, somewhat prorsiradiate on the lower part of the flank, gently convex on the mid-flank, gradually rursiradiate on the upper part of the flank, passing rather gradually the subrounded shoulder with a concave curvature and moderately projected on the venter. Thus the low and broad ribs on the outer whorl look sigmoidal in lateral view, in contrast with the rigid ribs on the inner whorls. The ribs are mostly simple but a few slightly shorter ribs are intercalated. The umbilical tubercles are much weakened and bullate. The ventrolateral tubercles are also weakened and are manifested by slight elevations on the ribs. The rib itself is asymmetric, with a gentle anterior and a steeper posterior inclination like a ripple-mark. Unlike other species, spinose or horn-like marginal tubercles are not developed on the outer whorl of this species.

In the observed suture on the inner whorl E is much deeper than L, the saddle between E and L is large and massive; L is of moderate depth and breadth, as is the saddle between L and U_2; the auxiliaries are somewhat ascending.

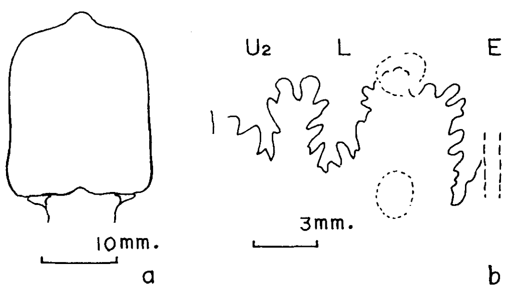


Fig. 17. *Prionocycloceras sigmoidale* sp. nov. Holotype, GK. H5435, from Ban-no-sawa, Ikushumbets. (a) Whorl-section; (b) external suture of the inner whorl. (T. M. *delin.*)

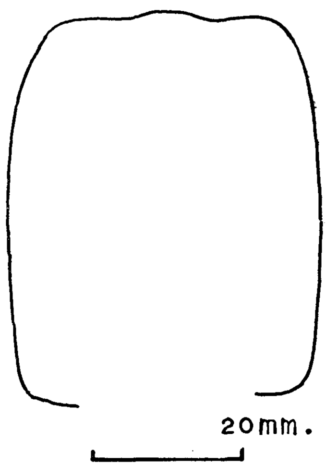


Fig. 18. *Prionocycloceras sigmoidale* sp. nov. Paratype, Mikasa High School Coll. 108, from Ban-no-sawa, Ikushumbets. Cross section of a fragmentary body-whorl. (T. M. *delin.*)

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
GK. H5435	58.8	21.0(0.35)	24.7(0.42)	19.7(0.33)	0.79
,, (−1/2 vol.)	35.5	11.8(0.33)	13.4(0.38)	11.7(0.33)	0.87
MHS. 108	—	—	51	42	0.82
P. mediotuberculatum (GERHARDT) (1897, p. 198) for comparison	62	21 (0.34)	26 (0.42)	19 (0.30)*	0.73

* misprinted as 0.40 in GERHARDT's paper.

Affinities.—Although this species is at present representated only by three specimens, it is so distinct that the establishment of a new species is warranted.

The inner whorl of the holotype is similar to *Prionocycloceras guayabanum* (STEINMANN) (*in* GERHARDT, 1897, p. 197, pl. 5, fig. 22a, b, c), from Colombia, in shell form and general aspects or ornamentation. In its rigid ribbing and strong tuberculation it is rather closer to *Prionocycloceras maarfiaense* SORNAY (1957, p. 191, pl. 16, figs. 8, 11), from the Coniacian of Constantine, Algeria, but its whorl is as compressed as that of *P. guayabanum*.

The outer whorl of the holotype of the present species somewhat resembles *Prionocycloceras mediotuberculatum* (GERHADT) (1897, p. 198, pl. 5, fig. 23a, b, c), from Colombia, in the high whorl, somewhat flexuous ribbing and comparatively weaker ventrolateral tubercles, but the latter has weak tubercle-like elevations at the convex points of the flexuous ribs at about the middle of the flank. This feature seems to be particular to that Colombian species and is never seen in other species of *Prionocycloceras*. The lowered, broadened, and dense ribs and weakened tubercles on the outer whorl are characteristic of the present species.

The sudden change of character at a particular growth-stage in this species is very interesting.

Occurrence.—Loc. near Ik1111, Bonnosawa, about 800 m. west from its confluence with the main stream of the Ikushumbets, fine-sandy siltstone of member IIIb, Upper Yezo Group, zone of *Inoceramus uwajimensis*. Two other localities in Ichinosawa, another tributary of the Ikushumbets, probably the same member and the same zone as the type locality.

Prionocycloceras sp. aff. *P. guayabanum* (STEINMANN)

Pl. 11, Fig. 4; Text-figs. 19, 20

Compare.—

1897. *Prionocyclus guayabanus* STEINMANN *in* GERHARDT, *Neues Jahrb. Min., Beil. Bd.*, vol. 11, p. 197, pl. 5, fig. 22a, b, c; text-fig. 19.
1936. *Prionocycloceras* aff. *guayabanus*, BESAIRIE, *Mém. l'Acad. Malgache*, fasc. 21, p. 203, pl. 24, figs. 19, 20.
1963. *Prionocycloceras guayabanum*, YOUNG, *Univ. Texas Publ.*, No. 6304, p. 67, pl. 23, figs. 3, 6; pl. 27, figs. 2, 3; text-figs. 12a, 14a, 33d.

Type of Prionocycloceras guayabanum.—This species was established (under *Prionocyclus*) on the basis of seven syntypes from the black limestone of the Rio Guayabo on the southwest side of the Cerro Pelado, southern Colombia, of which the illustrated one (GERHARDT, 1897, pl. 5, fig. 22a, b, c) is here designated as the lectotype.

Material.—GK. H5436, from Kami-ichi-no-sawa, a tributary of the Ikushumbets (Coll. T. & K. MURAMOTO); GK. H5488 [=transferred from GT. I-3187], from loc. IK. 964 (Coll. T. MATSUMOTO).

Descriptive remarks.—The above two specimens from Hokkaido are more or less fragmentary and of different growth-stages.

The first specimen (Pl. 11, Fig. 4; Text-fig. 19) resembles the illustrated syntype of *Prionocycloceras guayabanum* (STEINMANN *in* GERHARDT) (1897, p. 197, pl. 5, figs. 22a, b, c), from Colombia, in the subquadrate whorl, mode of ribbing and spinose, strong ventrolateral tubercles, as well as the finely serrate keel. It is approximately of the same growth-stage as the latter, although the specimen from Hokkaido is imperfectly preserved. Its whorl breadth (in a costal section excluding the spinose tubercles) is 16.5 mm when its height is 18.0 mm. This indicates that it is somewhat broader than the type of STEINMANN, with 0.92 as compared with 0.88 in the proportion of breadth to height. In this respect it may be rather closer to a specimen from Madagascar which was described by BESAIRIE (1936, p. 203, pl. 24, fig. 19, 20), but the measurements were not given in that Madagascar specimen.

It is interesting to see that the spines are preserved on one side of the specimen from Hokkaido and that the ventrolateral tubercles on the other side are rounded. I tried to cut off one of the spines and have confirmed that the spine is septate near its base, forming a rounded tubercle. The spine extends mainly laterally and slightly upwards.

Another feature to be noted in this specimen is the existence of faint node-like elevations on the projected ventral ribs ahead of the much stronger marginal tubercle. These elevations probably correspond to the reducing outer ventrolateral tubercles in *Prionocyclus* and are not comparable with the distinct ventral clavi of *Protexanites*. STEINMANN (*in* GERHARDT, 1897) did not mention of such tubercles in his original description. If they were existent, they must be very faint. The umbilical tubercles

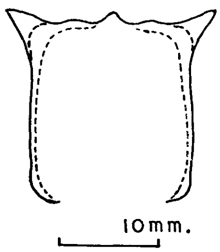


Fig. 19. *Prionocycloceras* n. sp. aff. *P. guayabanum* (STEINMANN). Whorl-section of GK. H5436, from Kami-ichi-no-sawa, a right tributary of the Ikushumbets. (T. M. *delin.*)

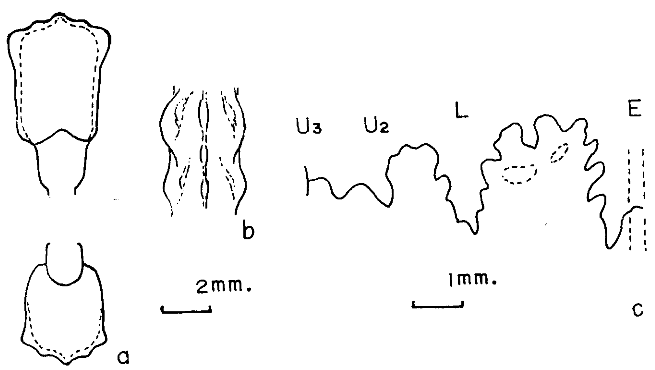


Fig. 20. *Prionocycloceras* sp. aff. *P. guayabanum* (STEINMANN). An immature specimen, GK. H5488, from loc. Ik. 964, Ikushumbets. (a) Whorl-section; (b) ventral view (in part); (c) external suture at whorl-height=4 mm. (T. M. *delin.*)

in GK. H5436 are nearly as weak as those in STEINMANN's figures. The ribs are simple, moderately distant on the earlier part of the whorl and become closer on the later part.

The second specimen, GK. H5488 (Text-fig. 20) is small, with a following dimensions (in mm.):

diameter=14.5 (1) umbilicus=4.2 (0.29)

height =5.2 (0.36) breadth =4.1 (0.28) b/h=0.79

It is certainly a young shell, but as regards the already known species no authors have described in detail the characters of the shell of this size, except for the originally small holotype of *Prionocycloceras maarfiaense* SORNAY (1957, p. 191, pl. 16, figs. 8, 11; text-fig. 1c), from Algeria. But it is distinguished from that species by weaker umbilical bullae, stronger ventrolateral tubercles, slender umbilical shoulder, and somewhat higher whorls. There is some difference in the suture between them (Compare Text-fig. 20c in this paper with text-fig. 1c in SORNAY's). In addition to the strong ventrolateral tubercles there are weaker ones close to and ahead of the former, and thus the ventrolateral tubercles are double. In this and other respects the small specimen at hand can be presumed as specifically identical with the first specimen. The whorl is fairly higher than broad and broadest in the ventral part, with slightly divergent flanks. This type of whorl shape is observable also in the first specimen, although the proportion of breadth to height is somewhat greater in the first specimen.

The inner whorls of this small specimen is nearly smoothish, but the whorl at a diameter of 6 mm already has a narrow keel and tiny ventrolateral tubercles and at a diameter of about 11 mm. the whorl rather suddenly begins to possess stronger ribs and tubercles. The ventral keel at this stage is fairly distinctly serrated, with more numerous serrations than ribs. The whorl at a diameter of about 6 mm. has a low roof-shaped venter and a gently sloping umbilical shoulder. The illustrated suture (Text-fig. 20c) is that of the immature stage immediately before the strongly ornate stage.

On the grounds of all the above observations I regard the two specimens from Ikushumbets as representing a species or a subspecies which is closely allied to but in certain respects distinguished from *Prionocycloceras guayabanum* from South America. More specimens from both areas are needed for a clearer conclusion.

Occurrence.—Loc. K1-20 of MURAMOTO in Kami-ichino-sawa, a right tributary of the Ikushumbets and loc. Ik964, on the main stream of the Ikushumbets, both from bed IIIb, lower part of the Upper Yezo Group, lower part of Lower Urakawa (K5α), approximately Coniacian. The two localities are inaccessible now, because they have been under the artificial lake of the Katsurazawa dam.

Prionocycloceras sp. aff. *P. lenti* (GERHARDT)

Pl. 11, Figs. 2, 3

Compare.—

1897. *Gauthiericeras lenti* GERHARDT, *Neues Jahrb. Min., Beil. Bd.*, vol. 11, p. 77, pl. 1, fig. 4a, b; text-fig. 3.

1958. *Prionocycloceras lenti*, REYMENT, *Stockholm Contributions in Geol.*, vol. 2, no. 1, p. 12, pl. 3, fig. 1a, b; text-fig. 4b.

Type of Prionocycloceras lenti.—Of the two syntypes of GERHARDT's species the original of the figure (GERHARDT, 1897, pl. 1, fig. 4a, b) is here designated as the lectotype. It came from "the Tachira, between Cana and Amarillo near Rubio, western Venezuela."

Material.—GK. H5489, from loc. Ik1110b and GK. H5492, from loc. Ik1111a, Ban-no-sawa, a tuributary of the Ikushumbets (Coll. T. MATSUMOTO).

Descriptive remarks.—The above two specimens are very incomplete, showing the outer part of the fragmentary whorls, and are of different size. Fine lirae and striae are fairly well preserved on the surface of these specimens.

The smaller specimen, GK. H5489 (Pl. 11, Fig. 2) shows some diagnostic features. The compressed whorl has a narrow, gently arched or almost flat venter and flattened flanks. The mid-ventral keel is low, bordered by very shallow grooves, and crossed by the projected ventral riblets, lirae and striae, which form blunt chevrons but cross the keel itself nearly vertically or with gently convex curve. The low keel is, thus, finely and weakly serrate.

The flank of this specimen is also covered with flexuous fine lirae, each several of which are bundled into a low, indistinct rib. The interspaces between the low ribs are also covered with the flexiradiate lirae and may be accompanied with indistinct furrows behind the ribs. At the ventrolateral shoulder the low ribs are elevated to low and small tubercles, some of which are bluntly spinose, and abruptly bent there to form a ventral projection. The ornaments look like sickles in lateral view. As the lower half of the whorl is not preserved, I cannot describe about the umbilical bullae as well as the umbilicus itself. The suture is also unknown.

So far as the observed character is concerned this specimen is very similar to *Prionocycloceras lenti* (GERHARDT) from western Venezuela. GERHARDT did not show the dimension of whorl breadth, but REYMENT (1958, p. 10) gave the dimensions of another specimen and estimated those for GERHARDT's figure. According to REYMENT's measurements the whorl is high and much compressed, with 0.58 as a proportion of breadth to height.

The specimen from Hokkaido is fairly compressed, but is probably is not so much compressed as *P. lenti*, although it is too fragmentary to be accurately measured.

The other specimen from Hokkaido, GK. H5492 (Pl. 11, Fig. 3) is a fragment of a large body-whorl. The lirae, striae, indistinct furrows and low and broad ribs on the flank and the venter are very similar to those on the smaller specimen. The ventrolateral node is blunt; the ventral keel is low and broad, being crossed by lirae, low furrows and low ribs with a gently convex curve. The two specimens can thus be referred to one and the same species, which is closely allied to *Prionocycloceras lenti* (GERHARDT), although a large body-whorl is not known in that South American species. The localities of the two specimens are very close and of the same bed.

Occurrence.—Loc. Ik1110b and loc. Ik1111a, green, fine-sandy siltstone, on banks of the Ban-no-sawa, about 800 m. upstream (i. e. westward) from the confluence with the Ikushumbets. The bed belongs to member IIIb, lower part of the Upper Yezo Group, zone of *Inoceramus uwajimensis*, Lower Urakawan, approximately Coniacian in terms of the international scale. This place is now hardly accessible, because it has been under the water of an artificial lake of the Katsurazawa dam since 1956.

Genus *Subprionotropis* Basse, 1950

Type-species.—*Subprionotropis colombianus* Basse, 1950 (by monotopy).

Generic diagnosis.—The shell is small and moderately to very involute. Whorls are compressed, with flat and nearly parallel or slightly divergent flanks, being broadest between the ventrolateral shoulders. The venter is roof-shaped, but has no mid-ventral keel. The umbilicus is small and shallow.

The whorl is ornamented with somewhat prorsiradiate ribs and also umbilical, ventrolateral and mid-ventral tubercles. The ribs start from the distinct umbilical tubercles in pairs, or singly with inserted secondary ribs. They are bent at the prominent ventrolateral tubercles, projected on the venter to form chevrons and intersect a row of more or less sharp mid-ventral clavi. The ventrolateral tubercle may be double, with a feeble outer elevation ahead of the strong inner tubercle. The ribs are comparatively more distant and the ornament is stronger on the outer whorl than on the inner.

The suture is rather simple, following the general pattern of the Collignoniceratinae.

Remarks.—*Subprionotropis* was established by Basse (1950, p. 250) for a single species, *S. colombianus* Basse (1950, p. 250, pl. 11, figs. 8–10), from the Coniacian of the Cordillère Orientale, Colombia. Wright (*in* Moore [Ed.], 1957, p. L427) indicated the occurrence of the same genus from Pondoland, but the full description of the South African species has not been published. This genus seems to be rather rare, but an example was fortunately discovered in Hokkaido.

The above diagnosis is not much different from the original description of Basse and also the concise one of Wright (in Moore [Ed.], 1957), but has been somewhat modified from them, so that not only the type-species but also a new species from Japan may be accomodated in the genus.

While the type species is recorded as of Coniacian age, a new species, to be described below, came from the upper part of Upper Gyliakian, probably the uppermost part of Turonian.

As Basse has pointed out, *Subprionotropis* is intimately allied to *Collignoniceras* (*s. s.*), but the former is distinguished from the latter by its small size, more involute whorls, absence of a high siphonal keel, bifurcate instead of simple ribbing, less distinct doubling of the ventrolateral tubercles at any growth-stage and more compressed whorls. In the mode of ribbing this genus may be similar to *Subprionocyclus*. but in that genus the outer ventrolateral clavi are better developed than the inner. Thus, *Subprionotropis* probably represents a short, specialized offshoot from the main stock of *Collignoniceras*-*Subprionocyclus*.

Subprionotropis muramotoi sp. nov.

Pl. 4, Fig. 5; Text-fig. 21

Material.—Holotype, GK. H5434, from loc. IK. 2012c, upper part of Member IIIa′, zone of *Inoceramus tenuistriatus*-*I. teshioensis*, Pombets, a tributary of the Ikushumbets, Hokkaido (Coll. T. MURAMOTO). The specific name is dedicated to Mr. Tatsuo MURAMOTO who has provided me this valuable specimen of his collection for study.

Diagnosis.—The shell is small, discoid, and moderately involute; the outer whorl embracing about a half of the inner. The whorl is compressed, increasing more rapidly in height, with a proportion of breadth to height about 7:10 in the body-whorl. The flanks are flattened, with a slight inflation, and nearly parallel or slightly convergent, being broadest between the ventrolateral shoulders. The venter is fastigate, with an obtuse angle in the whorl-section. The umbilicus is of moderate width, about 30 percent of the shell-diameter. It is shallow and bordered by a low but nearly perpendicular wall.

The whorls, except for the smoothish infant stage, are ornamented with numerous, more or less dense, somewhat prorsiradiate ribs, fairly strong umbilical bullae and ventrolateral tubercles. The ribs are very dense on the septate whorl but are less so on the body-whorl, where they are separated by interspaces somewhat wider than the ribs themselves. About six ribs are counted on the upper part of the flank within the distance equal to the height of the whorl. As a rule a primary rib springs from an umbilical bullae and is bufurcated above the bullae. For some ribs there is an intercalation of a short rib instead of the bifurcation. A few ribs are as long as the primaries, starting from the umbilical margin, but have no perceptible umbilical tubercle. All the ribs are provided with small but distinct ventrolateral tubercles, from which the ribs are projected and cross the mid-venter with chevrons. The mid-ventral clavi are low and the chevrons are predominat over the clavi. The ventrolateral tubercle may be indistinctly doubled. In other words, a feeble elevation may be discernible on the ventral rib close to and ahead of the distinct ventrolateral tubercle.

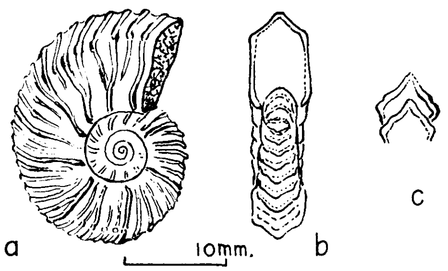


Fig. 21. *Subprionotropis muramotoi* sp. nov. Diagram restored from the holotype, GK. H5434, from loc. Ik. 2012c, Pombets. (a) Lateral view; (b) frontal view; (c) part of the ventral ribs in the late growth-stage. (T. M. *delin.*)

The suture is rather simple and of the general *Collignoniceras* pattern, although it is incompletely exposed.

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
GK. H5434	23.2(1)	7.4(0.32)	9.6(0.41)	6.6(0.28)	0.69
„ (−1/2 vol.)	—	—	6.5	4.8	0.75

Remarks.—Only a single specimen is available at present. It is, however, so characteristic that the establishment of a new species is warranted, especially under the circumstance that *Subprionotropis* is rare in the world. The variation of this species should be studied by further collecting.

Affinities.—The present species is allied to *Subprionotropis colombianus* BASSE (1950, p. 250, pl. 11, figs. 8–10), from Mutiscua, Colombia in the general shell-form and the mode of ornamentation, and is consequently best referred to the same genus. It is distinguished from that species by its finer, denser and much more numerous ribs and weaker tubercles than the latter.

The species from Japan is similar in lateral view to some immature finely ribbed, small shells of *Subprionocyclus neptuni* (GEINITZ), as illustrated previously (MATSUMOTO, 1959c, p. 112, pl. 30, fig. 1a, b, c), but the ribs are more flexuous in the latter. In ventral view it is readily distinguishable from the latter by its chevrons of the ventral ribs without such a distinct keel as in the latter. The inner ventrolateral tubercles are distinct in the former, while the outer ventrolateral tubercles are so in the latter.

Occurrence.—Loc. Ik 2012c, a small gully on the right side of the Pombets [=Ponbetsu], a tributary of the Ikushumbets, Hokkaido. *Prionocyclus cobbani*, *Lymaniceras planulatum* and *Inoceramus tenuistriatus* occurred in the same bed, which is probably Upper Turonian.

Genus *Subprionocyclus* SHIMIZU, 1932

Type-specie.—Prionotropis hitchinensis BILLINGHURST 1927 (by original designation).

Remarks.—I have already given the diagnosis of this genus and also its affinities with and distinctions from other genera (MATSUMOTO, 1959b, p. 108). Although this genus is very important in the evolution of the Collignoniceratidae, I would not repeat here the discussion. The ontogeny of some species are described in this paper. One of further works to be attempted may be a precise study of numerous specimens from the successive zones in the view point of population palaeontology. The material from Japan is not sufficiently numerous, although the succession of species is known.

I would agree with WRIGHT (letter of August 8, 1964) in pointing out the close resemblance between *Ledoceras massoni* BASSE (1962, p. 871, pl. 22, figs. 1-5), from the Upper Turonian of Uchaux, France, and *Subprionocyclus hitchinensis* (BILLINGHURST) (1927, p. 516, pl. 16, fig. 1), from the Chalk Rock of England, although the sutures of the French species were not illustrated. The former is the type-species of *Ledoceras* BASSE, 1962 and the latter that of *Subprionocyclus* SHIMIZU, 1932. Accordingly *Ledoceras* falls in synonymy of *Subprionocyclus*.

Subprionocyclus is world-wide in the Upper Turonian, but no examples have been found in the North American Interior province where *Prionocyclus* occurs abundantly. *Prionocyclus* and *Subprionocyclus* are both originated in *Collignoniceras* but are in parallel relationship, giving rise respectively to various genera of different groups.

In Japan there are three species of *Subprionocyclus*, *S. branneri*, *S. neptuni* and *S. normalis*, as in the Pacific Coast province of North America. In California and Oregon they occur in comparatively shallow sea sediments of a marginal facies, as I have pointed out (MATSUMOTO, 1960, p. 173). In Hokkaido the sediments of a similar environment must have been formed, but they seem to have been mostly eroded away and those of more or less off-shore facies have probably been preserved. This may be the reason why the three species occur in Hokkaido less abundantly than in California and Oregon. The specimens from Hokkaido so far known are mostly immature. There may be some difference in the habitat between the adult and immature animals, in view of the considerable difference in the morphological character of their shells.

Subprionocyclus branneri (ANDERSON)

Pl. 13, Fig. 2; Text-figs. 22-25

1896. *Prionotropis neptuni*, WOODS (*non* GEINITZ), *pro parte*, *Quart. Jour. Geol. Soc. London*, vol. 52, p. 77, pl. 3, fig. 3 only.
1902. *Prionotropis branneri* ANDERSON, *Proc. Calif. Acad. Sci.*, 3rd ser., vol. 2, no. 1, p. 125, pl. 1, figs. 11-16.
1909. *Prionotropis* cfr. *serratocarinatus*, YABE (*non* STOLICZKA), *Zeitschr. deutsch. geol. Gesell.*, vol. 61, p. 440.
1925. *Prionotropis teshioensis* YABE and SHIMIZU, *Sci. Rep. Tohoku Imp. Univ.*, ser. 2, vol. 7, p. 134 [10], pl. 21 [2], fig. 10; pl. 33 [4], figs. 6-10.
1927. *Prionotropis cristatum* BILLINGHURST, *Geol. Mag.*, vol. 64, p. 515, pl. 16, fig. 3a-c.
1951. *Collignoniceras cristatum*, WRIGHT and WRIGHT, *Palaeontogr. Soc.*, 1950, p. 30.
1954. *Subprionocyclus cristatus*, WRIGHT and MATSUMOTO, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 4, no. 2, p. 129.
1958. *Prionotropis branneri*, ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 261, pl. 34, figs. 1, 2, 3, 3a.
1958. *Prionotropis casperi* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 262, pl. 34, fig. 6; pl. 39, figs. 3, 4.
1959. *Subprionocyclus branneri*, MATSUMOTO, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, special vol. 1, p. 109, text-figs. 58, 59.

Lectotype.—The original specimen of ANDERSON, 1902, pl. 1, figs. 11, 12 from loc. CAS. 445A, Fitch ranch [Smith ranch], near Phoenix, Oregon, now preserved at the California Academy of Sciences (CAS. No. 48), San Francisco, as previously designated by myself (MATSUMOTO, 1959b, p. 109-110).

Material.—Several specimens under the same register number, IGPS. 8027, from the Obirashibets area, Teshio (Coll. H. YABE). They are holotype and paratypes of *Prionotropis teshioensis* YABE and SHIMIZU, 1925.

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
IGPS. 8027(a)*	38.2(1)	14.3(0.37)	15.5(0.40)	12.5(0.32)	0.80
IGPS. 8027(b)	—	—	13.0	10.3	0.79
IGPS. 8027(c)	—	—	4.8	4.1	0.85
CAS. 48	67.5(1)	24.2(0.36)	27.2(0.40)	22.8(0.33)	0.84
BM. C. 32291	44.0(1)	15.0(0.34)	17.6(0.40)	13.2(0.30)	0.75
GK. H9217**	31.4(1)	11.5(0.36)	11.8(0.37)	9.5(0.30)	0.80

* The dimensions do not conform with those recorded by YABE and SHIMIZU, 1925, when the specimen was not well cleaned.

** A specimen from the Chalk Rock, Hitchwood Pit, Hertfordshire, England, a gift from C. W. WRIGHT (Coll. No. 22773).

Descriptive remarks.—I have already given (MATSUMOTO, 1959b, p. 110-112) the diagnosis of *Subprionocyclus branneri* (ANDERSON) and its relation to and also distinction from *Collignoniceras woollgari* (MANTELL) and *Subprionocyclus neptuni* (GEINITZ). On that occasion I stated that *Prionotropis branneri* ANDERSON, 1902, from Oregon, and *Prionotropis cristatus* BILLINGHURST, 1927, from the Chalk Rock of England, are probably of identical species, although they might eventually be subspecifically distinguished.

There are several specimens from Hokkaido which are best referred to the present species. One of them is the holotype of *Prionotropis teshioensis* YABE and SHIMIZU 1925, p. 134 [10], pl. 33 [4], figs. 8, 9), which was considerably covered with rock matrix but has been cleaned and illustrated in this paper (Pl. 13, Fig. 2). It was at one time considered as an example of *Collignoniceras* from Japan, but actually is closely resembles the holotype and other examples of *Subprionocyclus branneri* (ANDERSON) and at the same time the holotype (BM. C. 32291) [the plaster cast of which is GK. H9216] and other examples of *Prionotropis cristatus* BILLINGHURST, in its little to moderate involution of the shell, moderately wide umbilicus (about 37 percent of the shell diameter), somewhat compressed outer whorls (with a proportion of breadth to height approximately 8:10), roughly subrectangular whorl-section with the maximum breath between umbilical bullae, distinctly serrate siphonal keel, prorsiradiate and sometimes gently flexuous, mostly simple but occasionally paired ribs, starting from the umbilical bullae which are highest at the umbilical shoulder, well developed inner and outer ventrolateral tubercles, of which outer ones are distinctly clavate, and the ventral clavi, which form the serrations of the keel, correspond to the ribs in number, and are situated somewhat ahead of the ventrolateral clavi, being linked by projected ventral ribs that form chevrons. The suture is not clearly exposed in the holotype. The third of the above measured specimens shows clearly the suture (Text-fig. 24b) which is probably the original of YABE and SHIMIZU, 1925, pl. 33, fig. 10.

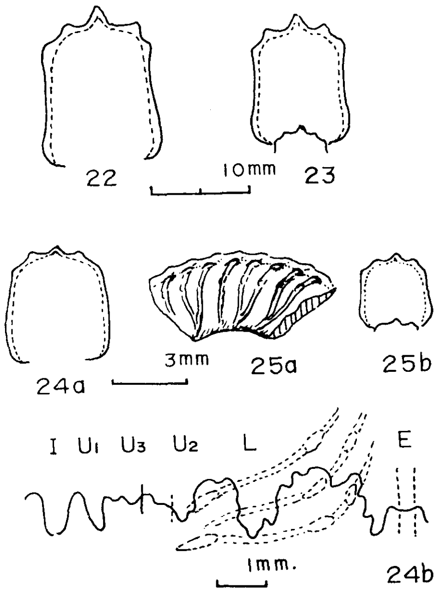


Fig. 22-25. *Subprionocyclus branneri* (ANDERSON). Four specimens of IGPS. 8027 [=holotype and paratypes of *Prionotropis teshioensis* YABE and SHIMIZU], from Obirashibets.

22, 23, 24a, 25b. Whorls of various growth-stages in cross-section.

24b. Suture of an immature specimen at whorl-height=c. 4 mm.

25a. Lateral view of another immature specimen. (T. M. *delin.*)

YABE and SHIMIZU's holotype shows the ribbing of the small inner whorls and thus can be connected with smaller immature shells from the same nodule. The young, small shell, as illustrated by YABE and SHIMIZU (1925, pl. 33, figs. 6, 7) and in this paper (Text-figs. 22-25), has sigmoidal ribs, which are alternately long and short, starting in pairs from the small umbilical tubercles or singly with intercalated secondaries, and provided with outer and inner ventrolateral tubercles. The outer ones are fairly close to the serrated siphonal keel but is separated from it by the furrows. The ribs are more crowded on the inner whorls than on the outer whorl.

The shell of this species in the middle grow-stage, as large as 30 to 40 mm. in diameter, is similar to that of *Collignoniceras woollgari* (MANTELL) (see p. 11). In the latter species, however, the distant ribs and strong tubercles of the adolescent stage normally appear rather rapidly and they are followed by the adult stage in which the inner ventrolateral tubercles are developed into the horns, absorbing the outer tubercles. In the present species a probably adult shell as large as 65 mm. in diameter, as seen in the holotype and other examples (e. g. ANDERSON, 1958, pl. 34, fig. 6) from California, has the same type of regular ornamentation as that of the shell of the middle growth-stage, keeping the row of the persistent outer ventrolateral clavi. The mode of ribbing in the young stage described above may be another distinction.

As I have already discussed in the preceding page, *S. branneri* may have been derived from a variant of highly plastic *Collignoniceras woollgari*. It probably represents an intermediate stage from *Collignoniceras* to *Subprionocyclus*.

Occurrence.—According to YABE and SHIMIZU (1925) the specimens were in a calcareous nodule found on the river floor of the Obirashibets, about 32 km. above its mouth, province of Teshio, and presumed to have come from the "*Scaphites* beds." K. TANAKA (1963), who published the details of the stratigraphy in the area of the Obirashibets valley (i. e. the Tappu and Horokanai quadrangles), did not find there the same species. "*Collignoniceras* (?) sp.", from Member Mn_1, in his list is a small shell of an infant stage, which is not identical with the young of the present species. (TANAKA's specimen, GK. H5524, resembles an infant shell of *Lymaniceras planulatum*.) "*Collignoniceras teshioense*" which was indicated at a horizon below the subzone of *Subprionocyclus neptuni* in my scheme of zonation (1959a, pls. 7, 8) is *Collignoniceras woollgari bakeri*.

The stratigraphic position of this species in Oregon is not precisely known. The British specimens occur in the Chalk Rock, Upper Turonian.

Subprionocyclus neptuni (GEINITZ)

Pl. 3, Fig. 5; Pl. 13, Figs. 1, 4; Text-figs. 26, 27

1849. *Ammonites neptuni* GEINITZ, *Das Quadersandstein oder Kreidegebirge in Deutschland*, pl. 3, fig. 3.

1959. *Subprionocyclus neptuni* (GEINITZ), MATSUMOTO, *Mem. Fac. Sci., Kyushu Univ., Ser. D, Geol.*, Special Vol. 2, p. 112, pl. 29, figs. 2, 3a, b; pl. 30, figs. 1a–c, 2a, b; text-figs. 60a, b, 61a, b, 63 (with full list of synonymy in p. 112).

Lectotype.—The specimen figured by GEINITZ (1849, pl. 3, fig. 3), from "dem Planerkalk von Strehlen, Sachsen," as designated by MATSUMOTO (1959b, p. 112).

Material.—Several incompletely preserved specimens from Hokkaido: GK. H5532a and other immature ones, from loc. IK2016a, Pombets (Coll. T. MATSUMOTO); GK.H5542, from loc. Yb 36p, Yubari dome (Coll. Masato HARADA); GK. H1501a, b from loc. Y132-4, Shuyubari (Coll. T. MATSUMOTO); GT. I-3325, I-3327 and I-3329 - I-3331, from loc. T670, Abeshinai area (Coll. T. MATSUMOTO); TKU. 30367, from loc. 70302, Haboro-Shumarinai area (Coll. W. HASHIMOTO).

Measurements.—

Specimen		Diameter	Umbilicus	Height	Breadth	B./H.
GK. H5532a		32.4(1)	11.2(0.34)	13.3	8.9	0.67
,,	(1/2 vol. early)	22.5(1)	8.5(0.37)	7.5	7.7[6.7]*	1.0[0.89]
,,	(1 vol. early)	15.0	6.0(0.40)	5.4	5.0	0.92
GK. H5542		27.0(1)	9.1(0.34)	9.8	3.4×2	0.69
GK. H1501a		10.2(1)	3.3(0.32)	4.1	3.0	0.74
GT. I-3327		20.3(1)	6.8(0.33)	7.9	5.1	0.65
GT. I-3330		10.8(1)	4.1(0.38)	3.9	3.2	0.82

* intercostal

Descriptive remarks.—In my previous paper (1959b) I described the diagnosis and also extent of variation of this species. The full-grown shell, from California, as large as 109 mm. in diameter was illustrated on that occasion. Such a large adult shell has not been found in Japan and seems to occur rarely even in California, Europe and other regions.

A specimen from Hokkaido, GK. H5532a, (Pl. 3, Fig. 5, Text-fig. 26) considerably resembles the lectotype of *Ammonites neptuni* GEINITZ, 1849, from Sachsen, Germany, in shell-form and ornamentation. The inner ventrolateral tubercles are very faint or almost indiscernible on the outermost part but are discernible on the whorl of the middle growth-stage. The same is true in another specimen, GK. H5542.

The first specimen (GK. H5532a) is accompanied by smaller, immature shells which are compressed and ornamented with numerous, dense, fine ribs. Several species from loc. T670 are probably also immature shells of the present species. Such a finely costate and compressed immature shell is commonly known in Europe and in California, too. It seems to foreshadow the characters of the descendants, *Subprionocyclus normalis* and furthermore *Reesidites minimus*. There is of course variation even in the immature shells. Some are less compressed and have coarser ornaments. A few are more widely umbilicate than many others.

Another small shell of an infant stage, GK. H1501a, from Shuyubari, is illustrated here (Pl. 13, Fig. 1; Text-fig. 27) to show an ontogenetic development. As seen in this specimen the initial three whorls are rounded and smoothish. At the diameter of about 4 mm. in the early part of the fourth whorl weak ribs begin to develop at first singly but soon some of them spring in pairs from the umbilical margin. They are gently flexuous on the flank, curving considerably forward on its outer part, and terminate at the ventrolateral tubercles. The keel is already serrate in this stage. The whorl becomes gradually compressed, with a fairly narrow venter and subangular ventrolateral shoulders.

The prominent umbilical bullae begin to develop at the shell diameter of 8 mm. in the early part of the fifth whorl. Most of the ribs spring in pairs from the umbilical bullae but a few of them are simple. They are numerous, moderately strong and gently flexuous. Small inner ventrolateral tubercles are discernible on some of the ribs in the fifth whorl. In the same stage the whorl becomes distinctly trapezoidal in section, acquiring subangular umbilical shoulders, steeply inclined or nearly vertical umbilical walls, flattened and somewhat convergent flanks, distinct, outer ventrolateral shoulders, less distinct, sloping inner ventrolateral shoulders and a narrow venter provided with a moderately high, serrate keel and chevrons.

It is noted that the ornament appears in this example somewhat earlier than in *Subprionocyclus normalis* and *Reesidites minimus*.

The suture consists of E, L, U_2, U_3 (=S), U_1, I. Lateral lobes are V-shaped in general outline, while saddles are massive. Minor subdivisions begin to develop in the fifth whorl.

Prionotropis bravaisianus (D'ORBIGNY) (ROMAN and MAZERAN, 1913, p. 22, pls. 1, figs. 13–17), from the Turonian of Uchaux, France, is a species of *Subprionocyclus*, which is closely allied to, if not identical with, *S. neptuni* (GEINITZ). Some of the smaller, probably immature specimens illustrated by ROMAN and MAZERAN (1913, pl. 1, figs. 13–15) are very similar to the immature specimens of *S. neptuni* from Hokkaido, although they are on the average less involute than *S. neptuni*. *Prionotropis* sp. of the same authors (1913, p. 24, pl. 1, figs. 18, 19) is still closer to the immature examples of *S. neptuni* described above.

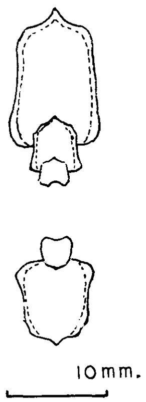


Fig. 26. *Subprionocyclus neptuni* (GEINITZ). Whorl-section of GK. H5532a, from loc. Ik2016a, Pombets. (T. M. *delin.*)

Occurrence.—Loc. IK2016a, Pombets, in a silty fine sandstone in the upper part of the Mikasa Formation on the western wing of the Ikushumbets anticline; loc. Yb36p, the fourth tributary of the Ponhorokabets, Member Mk 4, Mikasa Formation of the Yubari dome; loc. Y132.4, Member IIs, upper part of the Saku Formation, in the section of the main stream of the Shuyubari; loc. T670, Saku Formation,

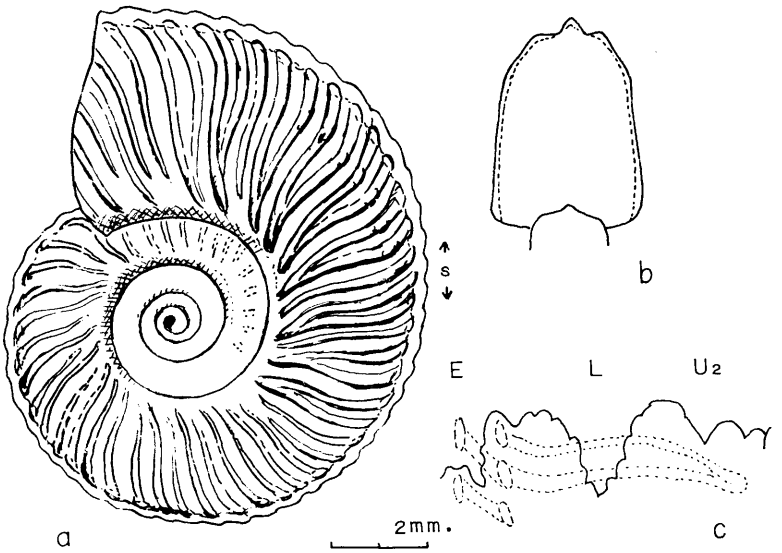


Fig. 27. *Subprinocyclus neptuni* (GEINITZ). Example of an immature shell, GK. H1501a, from loc. Y132-4, Shuyubari. (a) Lateral view; (b) Whorl-section; (c) Suture exposed at s in Fig. a. (T. M. *delin.*)

lower course of the Chirashinai, Abeshinai-Saku area, Teshio Province; loc. 70302 of W. HASHIMOTO, in boulder, upper reaches of the Shumarinai (right branch), lower part of the Haborodake Formation, equivalent of the Saku Formation in the Teshio Range of the Haboro area.

Subprionocyclus normalis (ANDERSON)

Pl. 12, Figs. 1-5; Pl. 13, Fig. 3; Text-figs. 28-33

1958. *Oregoniceras normale* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 268, pl. 25, fig. 8, 8a.
1959. *Subprionocyclus normalis*, MATSUMOTO, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, Special Vol. 1, p. 118, pl. 29, fig. la, b; pl. 31, figs. 1a-d, 2a-d, 3, 4a-b, 5a-b; text-figs. 64a-b, 65, 66a-b.

Holotype.—The specimen (CAS. Coll.) illustrated by ANDERSON (1958, p. 268, pl. 25, fig. 8, 8a), from "Forty-nine mine, 2 miles south of Phoenix, Oregon" (original designation).

Material.—The specimens from Hokkaido here described are GK. H5202, from Teshio province (Coll. Shogo NAGAOKA); TKU. 30368 and TKU. 30369, from the Haboro area (W. HASHIMOTO Coll.); GK. H5497 and GK. H5498, from loc. Ik2014 (Coll. YOSHIMOTO, a student of Mikasa High School and T. MATSUMOTO); GK. H5499a, b, from loc. Ik1181, Katsura-zawa dam, Ikushumbets (Coll. T. MATSUMOTO and T. MURAMOTO); GK. H5496 (an infant shell), from loc. Ik971, Ikushumbets (Coll. T. MATSUMOTO).

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.	Tubercles umbilical / ventrolateral
GK. H5202	20.4(1)	4.3(0.21)	9.8	5.0	0.51	(6/15)×2
„ (crushed last whorl)						11/24
GK. H5498	22.7(1)	5.8(0.25)	9.7	5.5	0.56	
„ (¼ vol. later)	25.5(1)	6.7(0.26)	11.2	7.3	0.65	(deformed)
„ (½ vol. later) (crushed body whorl)						14/25
GK.H5499a	26.4(1)	5.2(0.19)	13.6	7.2	0.53	10/26
Holotype*	42.2	9.5(0.22)	22.0	11.8	0.53	11/27+2?

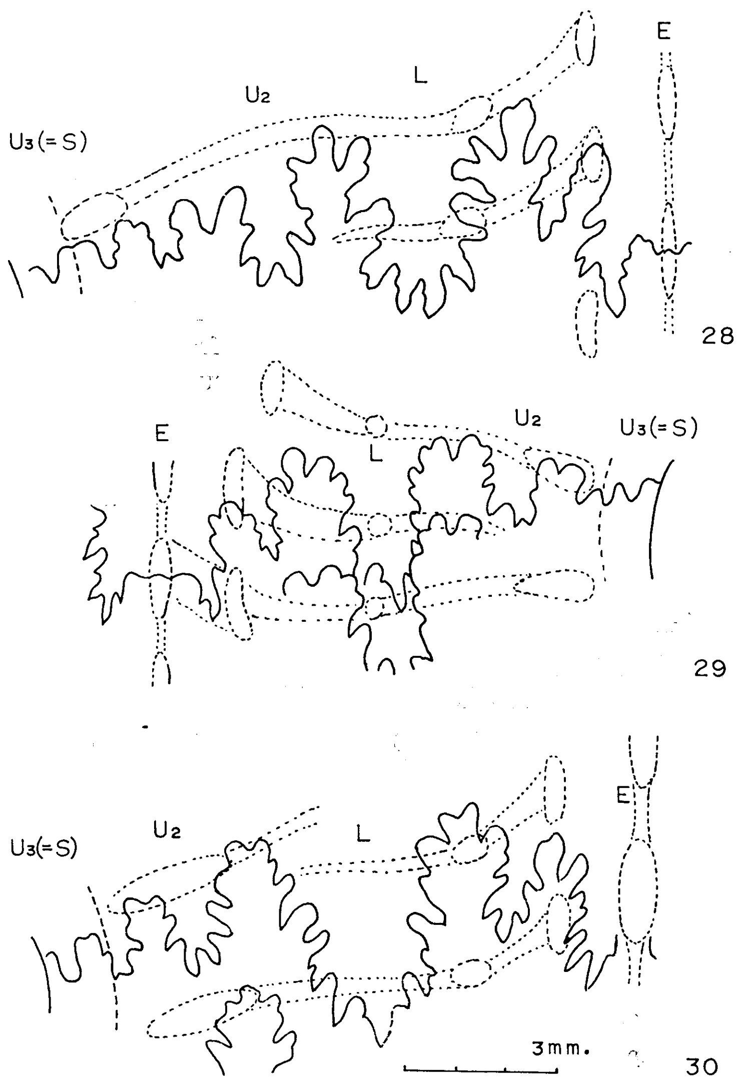
* Specimen from California shown for comparison

Descriptive remarks.—I have given in my previous paper (MATSUMOTO, 1959b, p. 119-120) the diagnosis and variation of *Subprionocyclus normalis* (ANDERSON). The specimens from Hokkaido show the same diagnostic features and are within the variation of that species.

Specimen GK. H5499a (Pl. 12, Fig. 4), for instance, closely resembles GK. H7041 (MATSUMOTO, 1959b, pl. 31, fig. 4a, b) from California in the comparatively narrowly umbilicate and compressed whorls as well as mode of ornamentation. Its last part, although incompletely preserved and excluded from the measurements, has fairly strong umbilical bullae as in that California specimen. Its proportion of breadth to height is somewhat smaller than that of H7041 but is well within the variation of *S. normalis* (see measurements in p. 119 of MATSUMOTO, 1959b).

Another specimen, GK. H5498 (Pl. 13, Fig. 3), is again fairly compressed, if not so remarkably as the preceding. The number of the umbilical bullae is 14 in the last whorl. This may be slightly more numerous than that of the average (10 or 11) of the examples of similar size from California, but is still within the extent of variation. The body whorl begins at the diameter of 23 mm., and accordingly the shell is smaller than many examples from California and Oregon.

In still another specimen, GK. H5202, the approximated last suture is seen at the shell diameter of about 20 mm., and the crushed body whorl is preserved for about



Figs. 28–30. *Subprinocyclus normalis* (ANDERSON). External sutures, showing the disposition of ribs, tubercles and ventral keel with dotted lines.

28. GK. H5499a, from loc. Ik1811, Ikushumbets (at whorl-height=12 mm.).
29. GK. H5202, NAGAOKA's Coll. (at whorl-height=8.5 mm.).
30. GK. H5498, from loc. 2014, Pombets (at whorl-height=9.2 mm.).

(T. M. *delin.*)

a half whorl as in the preceding specimen. The full-grown shell in the Japanese material can thus be regardèd as somewhat smaller than that of the Californian examples. GK. H5202 is again much compressed and narrowly umbilicate.

From these insufficient number of specimens, however, it is hardly decided whether or not the specimens from Hokkaido are subspecifically distinguishable from those from California and Oregon, although the possibility of the subspecific distinction could be suggested on the grounds of the above observation.

The sutures of the above three specimens are illustrated here (Text-fig. 28–30). Although there are minor differences between individuals, they are similar in the general pattern to one another and to those of the specimens from California and Oregon. The common features are the farirly deep first lateral lobe (L), about a half smaller second lateral lobe (U_2), a still smaller auxiliaries [i. e. subdivision of U_3 (=S)], and the highly asymmetric saddle between E and L with a lower and oblique outer branch separated by a fairly deep and narrow lobule from a higher and larger inner branch.

The suture of GK. H5499a (Fig. 28), at whorl height of 12 mm., which is the last third one, has fairly deep lobules and fairly narrow folioles. That of GK. H5202 (Fig. 29), at whorl height of 8.5 mm., is the last suture in this specimen but the lobules are not so deep and the folioles are massive and somewhat phylloid at the terminals. That of GK. H5498 (Fig. 30) is rather intermediate in this respect.

Description of infant shells.—GK. H5496 and GK. H5499b (and also several others), which are less than 9 mm. in diameter, came from the same bed or even from the same nodule as that of GK. H5499a. They can be regarded as infant shells of the same species. A specimen of similar size, which was extracted from an unmistakable specimen (GK. H7061a) of *S. normalis*, from loc. TM. 2001 [=LSJU. 3288], California, has been also studied for comparison. On the previous occasion (MATSUMOTO, 1959b) the young shell as small as this size was not described in detail.

Measurements come at first:

Specimen [Vol.]	Diameter	Umbilicus	Height	Breadth	B./H.
GK. H7061a [$4\frac{1}{6}$]	6. 5(1)	1. 8(0. 27)	3. 0	1. 9	0. 63
,, ,, [$3\frac{1}{6}$]	3. 0(1)	1. 1(0. 37)	1. 2	1. 0	0. 83
GK. H5496 [$4\frac{1}{4}$]	8. 3(1)	2. 1(0. 25)	4. 0	2. 5	0. 62
,, ,, [$3\frac{3}{4}$]	5. 6(1)	1. 9(0. 34)	2. 2	1. 8	0. 81
,, ,, [$3\frac{1}{4}$]	3. 5(1)	1. 4(0. 40)	1. 3	1. 2(−)	0. 92
,, ,, [$2\frac{1}{4}$]	1. 85(1)	0. 75(0. 40)	0. 54	0. 75	1. 39
,, ,, [$1\frac{1}{4}$]	0. 92	—	0. 42	0. 50	1. 2
GK. H5499b [$4\frac{1}{4}$]	8. 9(1)	2. 4(0. 27)	3. 8	2. 2	0. 57
,, ,, [$3\frac{1}{4}$]	5. 6(1)	2. 0(0. 35)	2. 3	1. 8	0. 78

N. B. Vol. $4\frac{1}{6}$ is in the early part (at about 60° from the beginning) of the fifth whorl.

The protoconch is very small and partly enveloped by the first whorl; its exposed part is about 0.15 mm. high in lateral view. The first three whorls are evolute and depressed, having inflated flanks and a more or less broadly rounded venter; the proportion of breadth to height gradually decreasing with growth. In this stage the surface is smooth and the suture is simple, consisting at first of [E, L, U_2, U_1, I] and then of [E, L, U_2, U_3 (=S), U_1, I].

At about the beginning of the fourth whorl, with a diameter of about 3 mm., there occurs a rather sudden change in shell-form. The whorl becomes higher than broad, increasing more rapidly in height than in breadth. A faint siphonal keel begins to appear and the ventrolateral shoulder is discernible. The umbilical shoulder is at first sloping but rapidly becomes subrounded, acquiring a steep umbilical wall. Thus the whorl is cordate in section, broadest in the lower part. It overlaps slightly less than a half of the inner whorl. The notable modification in the suture-line is that the massive saddle between E and L is shallowly but asymmetrically divided, with the inner part higher and broader than the outer one. L begins to be faintly incised. Other elements are entire.

The main part of the fourth whorl is distinctly compressed, with gently inflated flanks, broadest somewhat below the mid-flank, and considerably involute, overlaping more than a half of the inner whorl. The venter is narrow, roof-shaped, sharply carinate on top and provided with distinct, angular ventrolateral shoulders. The surface of the flank is ornamented with gently flexuous lirae and very faint sub-costate. The keel is gently wavy on top and the ventrolateral edge is also faintly wavy, consisting of a train of low and very thin clavae each of which forms the outer end of a faint subcosta. In the suture the saddle between E and L is fairly

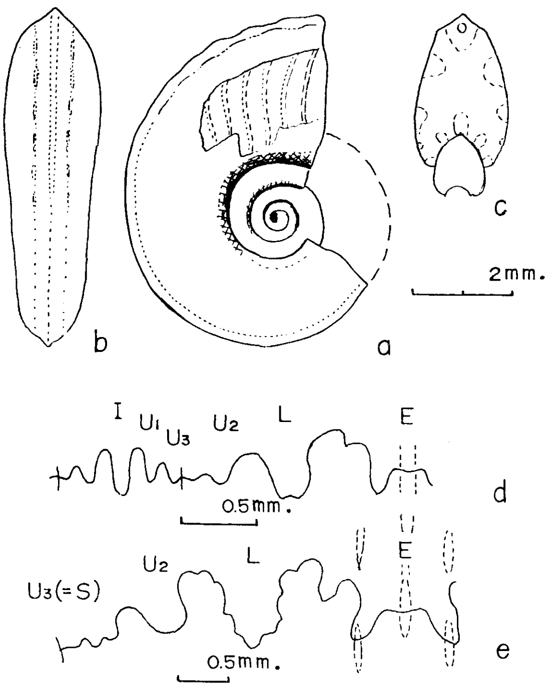
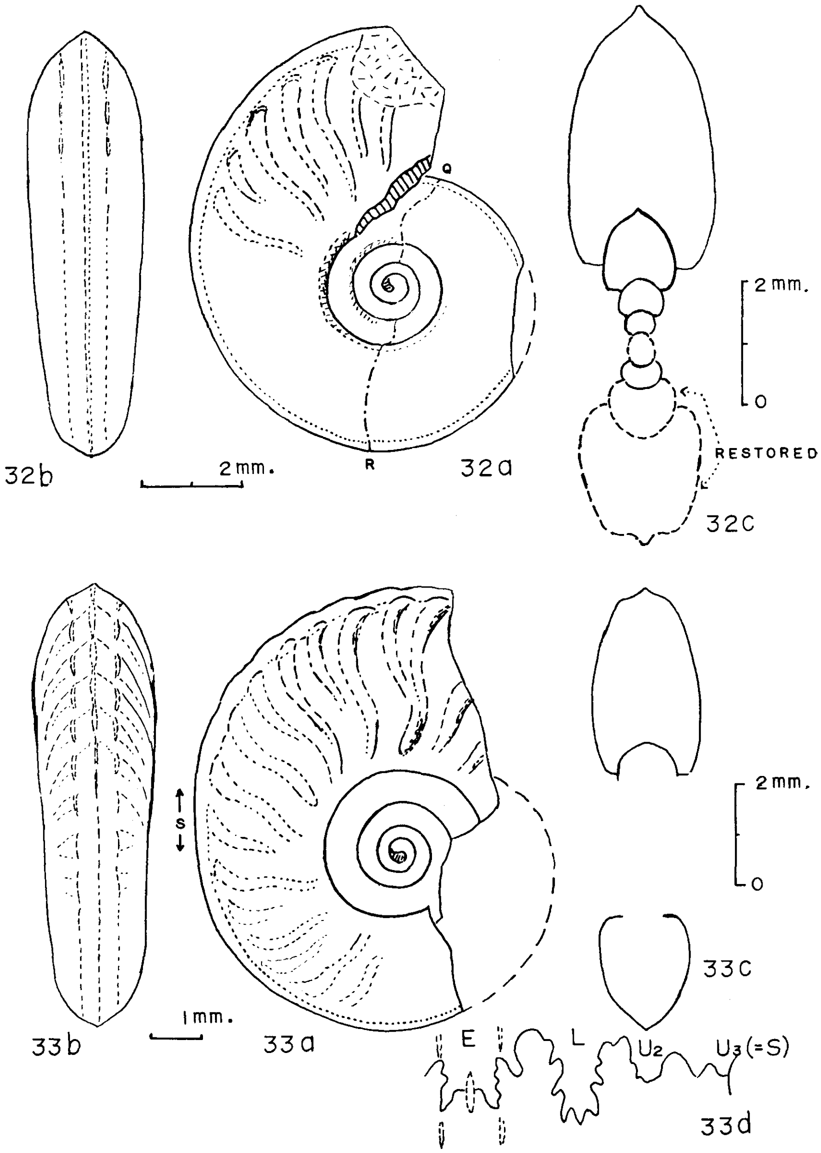


Fig. 31. *Subprionocyclus normalis* (ANDERSON). An infant shell, GK. H7061a, from loc. TM. 2001, Little Cow Creek, Member III of the Redding area, California. (a) Lateral view. The test is preserved on a portion of the posterior part. (b) Ventral view; (c) whorl-section; (d) suture at whorl-height=1.3 mm.; (e) suture at whorl-height =2.7 mm. (T. M. *delin.*)



Figs. 32, 33. *Subprionocyclus normalis* (ANDERSON). Diagrammatic sketches of infant shells from Hokkaido.

32. GK. H5496, from loc. Ik971, Ikushumbets. The specimen is separable into two parts by a crack QR. (a) Lateral view; (b) ventral view; (c) whorl-section (deformed part restored).
33. GK. H5499, from loc. Ik1181, Ikushumbets. (a) Lateral view; (b) ventral view; (c) whorl-section; (d) suture at s in Fig. 33a. (T. M. *delin.*)

deeply and asymmetrically divided, with a smaller outer branch obliquely disposed. L is considerably broad, deep, and minutely multipartite. U_2 and twice subdivided U_3 form descending auxiliaries.

In the fifth whorl, with diameters over 7 mm. or so, well discernible ribs are developed. Normally they spring in pairs from the prorsiradiate umbilical bullae and some secondaries may be intercalated in addition to them. The ribs are flexuous and prorsiradiate and bent at the ventrolateral clavi, projected on the venter forming chevrons. The inner ventrolateral nodes are not yet developed at least in the early part of the fifth whorl. The row of thin ventrolateral clavi forms a distinct, angular shoulder, which is situated fairly close to the gently serrate median keel. The shell-form acquired in the fourth whorl is extended with slight modification. The flank is more flattened than in the preceding stage and the umbilical wall becomes nearly vertical. The suture continues to develop, keeping the same fundamental pattern as that in the fourth whorl. As a gradual change L itself and also its incisions are deepened and minor incisions are added on the sides of E, at the bottom of U_2 and on the saddle between L and U_2.

There are slight differences between individuals of the infant stage. In GK. H5499b, for instance, the distinct ribbing appears somewhat earlier and more strongly than in others.

The specific diagnosis described in my previous paper (MATSUMOTO, 1959b, p. 119–120) is well manifested in the shells over 15 mm. or so in diameter. The inner ventrolateral nodes are developed sooner or later at the bending points of the flexuous ribs. They are small and discernible on the whorl of a relatively limited period of the middle growth-stage. The description of the other features in this stage is not repeated here.

Affinities.—I have already (MATSUMOTO, 1959b, p. 121) discussed the affinity and distinction between *Subprionocyclus normalis* and *S. neptuni* on one hand and those between *S. normalis* and *Reesidites minimus* on the other.

In the section along the creek of the Pombets, a branch of the Ikushumbets, *S. neptuni* came from a silty bed in the upper part of the Mikasa Sandstone Formation (on the western wing of the Ikushumbets anticline) which is stratigraphically lower than the lower part of the Upper Yezo Group where *S. normalis* was found. An example of *Reesidites minimus* was collected at a horizon above that of *S. normalis* in the same Pombets section. Unfortunately the three species do not occur so abundantly as to enable us to examine the changes from population to population. On the eastern wing of the same anticline the first species has not been found, the second species (*S. normalis*) is occasionally found in the First Green Sandstone Bed in the lower part of the Upper Yezo Group, and the third species (*R. minimus*) occurs abundantly in a bed between the First and the Second Green Sandstones. Dr. OBATA is undertaking a precise study of the ontogeny and variation of the last species.

The infant shell of *S. normalis*, as described above, closely resembles that of *Reesidites minimus*. The distinction is evident in the middle growth-stage, in which *S. normalis* has small, inner ventrolateral tubercles but *R. minimus* is free from them. In this and late growth stages, *R. minimus* has more numerous and finer ribs than

S. normalis, although there are variations in both species.

It is interesting to note that the faintly ribbed and finely carninate fourth whorl in the infant stage of *S. normalis* (and also *R. minimus*) resembles whorls of a certain later growth-stage of *Niceforoceras flexuosum* (GERHARDT) (1897, p. 157, pl. 4, fig. 1) and those of middle growth-stage of *Paralenticeras spathi* REYMENT (1958a, p. 17, pl. 1, fig. 6; pl. 2, fig. 5; pl. 3, fig. 4; pl. 4, fig. 2a, b) from the Coniacian of South America, although the latter two species are more compressed and much more involute. The asymmetrically divided and accordingly outward descending subdivisions of the saddle between E and L are characteristic of *S. normalis* and *R. minimus*. Their sutural pattern may also foretell that of *Paralenticeras* (see GERHARDT, 1897, p. 79, text-fig. 5 and REYMENT, 1958, p. 19, text-fig. 6).

Occurrence.—Loc. Ik971 and loc. Ik1181 on the main stream of the Ikushumbets (the former being at present under the water of the artificial lake of the Katsurazawa dam), not rare in the First Green Sandstone Bed in Member IIIa, lower part of the Upper Yezo Group on the eastern wing of the Ikushumbets anticline; loc. Ik 2014, on the right side of the Pombets, fine-sandy siltstone in the basal part of the Upper Yezo Group on the western wing of the same anticline. Locs. 287 and 70302 of W. HASHIMOTO, boulders in the upper reaches of the Haboro and the Shumarinai, derived from the equivalent of the Saku Formation (locally called the Haborodake Formation*) in the Haboro area, the Teshio Range, northwest Hokkaido. Another uncertain locality in Teshio Province (NAGAOKA's Coll.)

The species occurs fairly abundantly in the middle to upper part of Member III of the Cretaceous sequence in the Redding area, and also other areas in California and Oregon. It probably indicates an Upper Turonian age. In Japan it occurs in the zone of *Inoceramus teshioensis*, somewhat below the top of the Upper Gyliakian, probably Upper Turonian. BASSE (1962, p. 874, pl. 23, fig. 3) has recently reported *Subprionocyclus* cf. *normalis* from Angola.

Genus *Reesidites* WRIGHT and MATSUMOTO, 1954

Type-species.—*Barroisiceras minimum* (YABE MS.) HAYASAKA and FUKADA, 1951 (by original designation).

Generic diagnosis.—The shell is of small to moderate size, slightly exceeding 100 mm. in the known maximum diameter. The whorl is much involute, narrowly umbilicate, compressed and provided with a serrate keel on the top of the narrow, fastigate venter.

The ribs are numerous and sinuous, springing in twos or threes from the umbilical bullae. There are in addition some intercalated, shorter ribs. All the ribs are provided with clavi at the ventrolateral shoulder. On the inner whorls the rib is bent forward at a point somewhat below the ventrolateral clavus, but no tubercle is developed in any stage at the bending point. On the venter the ribs are projected, forming

* Professor W. HASHIMOTO is engaged, with his associates, in the stratigraphic study of this area and the details of their results will eventually be published. The Haborodake Formation is, according to him, Turonian.

chevrons on crossing the keel. Each serration of the keel corresponds with each rib. The ribs may be somewhat broadened on the outermost whorl, but the ventrolateral and ventral clavi remain distinct.

The suture consists of E, L, U_2, U_3 (=S), U_1, I. E is, as deep as, or shallower than, and somewhat broader than L. Other elements decrease in size and descend towards the umbilical seam. They are moderately incised. The saddle between E and L is deeply and obliquely divided, resulting in a modified asymmetric outline with an erect and taller, main branch on the inner side and a smaller, somewhat oblique one on the outer side. L is as a rule bipartite, but may be modified.

Remarks.—*Barroisiceras minimum* YABE was listed (*in* YABE and SHIMIZU, 1925, p. 125) but not described. I intended to propose a new generic name *Reesidites* for this species, indicating it in several lists (MATSUMOTO, 1942, p. 197 and other pages) without giving necessary definition. Accordingly the genus was a *nomen nudum*. The description of the species was first published by HAYASAKA and FUKADA (1951, p. 325, pl. 1, figs. 1-3; pl. 2, figs. 1-7), who referred it to *Barroisiceras*. The genus *Reesidites* was made valid by WRIGHT and MATSUMOTO (1954, p. 130), who designated *Barroisiceras minimum* HAYASAKA and FUKADA as its type-species and gave its diagnosis, with a discussion of its affinity with and distinction from *Subprionocyclus*.

Affinities.—For reasons of morphological resemblance (see the description of species below) and of stratigraphically successive occurrence, *Reesidites* is certainly a derivative of *Subprionocyclus*. The distinction is, among others, the complete disappearance of the inner ventrolateral tubercles in *Reesidites*. The affinity of *R. minimus*, the type-species, with *Subprionocyclus normalis* is so close that I still hold the view that *Reesidites* is better ascribed to Collignoniceratinae than to Barroisiceratinae.

Reesidites is similar to *Barroisiceras* (*s. s.*) in the involute and compressed whorl, fastigate venter, serrate keel, ventrolateral clavi and the umbilical tubercles from which the ribs are branched. In *Barroisiceras* the ribs are not so sinuous as in *Reesidites*. In the former the umbilical tubercles are less numerous and coarser and the whorl is generally more thickened around the umbilical margin than in the latter. There is also some difference in the suture. The modified pattern of the first lateral saddle (between E and L), for instance, is particular to *Reesidites*. It might be still considered that a certain group of compressed *Barroisiceras* descended from *Subprionocyclus* by way of *Reesidites*. This could remain as a possible line of descent, but does not seem satisfactory source for various other forms of *Barroisiceras*. In the mode of life the two genera must have been somewhat different. *Reesidites*, which has a compressed shell with numerous, rather fine, sinuous ribs, may presumably have been a quicker swimmer than *Barroisiceras*. The latter has a shell-form which is more or less inflated around the umbilical margin, prominent, sometimes mammilate, umbilical tubercles and nearly radial or simply curved broader ribs, occasionally with flared ventrolateral tubercles. These characters may have been suitable for slower swimming and keeping balance of buoyancy.

Reesidites is somewhat similar to *Niceforoceras* BASSE, 1948, but the latter was probably led form *Subprionocyclus* with the tendency to weakening of ribs and smoothing of a keel. Consequently they are parallel offshoots. Whether *Paralenticeras* and other members of the Lenticeratinae followed *Reesidites* or *Niceforoceras* or otherwise is not yet settled. A few genera which have been temporarily ascribed to Lenticeratinae may be derivatives of other collignoniceratid genera, with a similar smooth-of a keel. It is interesting to note that the suture of *Reesidites* is modified in such a way as could lead to that of Lenticeratinae. A tendency to a similar sutural modification is discernible in *Subprionocyclus normalis* and also in *S. hitchinensis*. The suture of typical *Niceforoceras* is not well known. REYMENT has shown an interesting immature specimen of *Paralenticeras spathi* REYMENT (1958, p. 17, pl. 4, fig. 2a, b), from Venezuela, which has sinuous weak ribs, faint ventrolateral tubercles and a lightly undulated keel. These characters seem to be reminiscent of *Niceforoceras* or *Reesidites*. On the other hand the early young shell of *Reesidites* or even that of some *Subprionocyclus* has a character which can be interpreted as a foreshadow of *Paralenticeras*.

Schloenbachia subtuberculata GERHARDT (1897, p. 156, pl. 3, fig. 12), from the South American Cordillera, was referred to *Reesidites* by REYMENT (1958a), with whom I would agree. *Schloenbachia oregenensis* ANDERSON (1902, p. 122, pl. 2, figs. 48–57; pl. 6, fig. 144; pl. 7, figs. 149, 150), from the Turonian of Oregon and California, was designated as the type-species of *Oregoniceras* ANDERSON (1958, p. 263). This is based on small specimens which have no inner ventrolateral tubercles. They may be either young shells of *Subprionocyclus* or shells of *Reesidites* in the early to middle growth-stages.

Barroisiceras sequens DE GROSSOUVE (1894, p. 64, pl. 3, fig. 1), from the Coniacian of France, which has sinuous ribs, may be a *Niceforoceras* rather than a species of *Reesidtes*, because GROSSOUVRE's figure shows a smoothish ventral keel.

Distribution.—In Japan *Reesidites* characteristically occurs in the uppermost part of Upper Gyliakian, upper part of the zone of *Inoceramus teshioensis* below the Lower Urakawan (Coniacian) beds with *Inoceramus uwajimensis* and species of *Barroisiceras*. This probably corresponds to the Uppermost Turonian in the international scale.

The bed with *Reesidites subtuberculatus* was assigned to Conician by REYMENT (1958a), but more precise zonal subdivision has to be attemped in the Cretaceous sequence of Colombia and Venezuela.

Reesidites minimus (HAYASAKA and FUKADA)

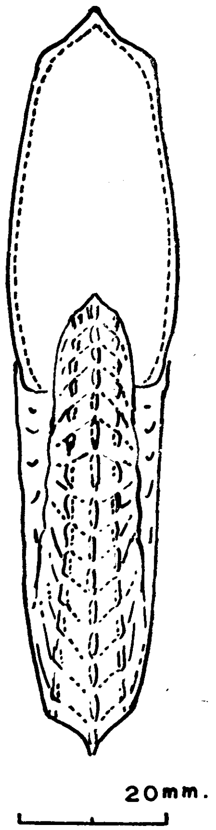
Pl. 14, Fig. 1; Pl. 15, Figs. 1–3; Text-figs. 34–39

1951. *Barroisiceras minimum* YABE (MS.), HAYASAKA and FUKADA, *Jour. Fac. Sci., Hokkaido Univ.*, ser. 4, vol. 7, no. 4, p. 325, pl. 1, figs. 1–4; pl. 2, figs. 1–7.

1954. *Reesidites minimus*, WRIGHT and MATSUMOTO, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 4, no. 2, p. 130.

Holotype.—The specimen which was originally designated by HAYASAKA and FUKADA (1951, p. 326, pl. 1, figs. 1–4). It is probably an adult shell. It came from a cliff 200 m*

* HAYASAKA and FUKADA (1951, p. 327) recorded this as 100 m, but actually the locality was about 200m apart northwestward from the confluence.



below the confluence of the Ban-no-sawa with the main stream of the Ikushumbets. It should be preserved at the Department of Geology and Mineralogy, Hokkaido University, Sapporo. but is still in the private possession of Dr, FUKADA, at Komagome in Tokyo. It was temporarily borrowed by OBATA to the National Science Museum, where I made an observation. Its plaster casts are in the same Museum and also in the Type Specimen Room of Kyushu University, GK. H5546.

Material.—In addition to the holotype, I have studied numerous specimens, from the type locality and other exposure of the same bed, in the collection of Kyushu University. They were obtained mostly by myself, sometimes assisted by T. MURAMOTO, K. MURAMOTO and T. OMORI. Some were donated through N. KAMBE from the Geological Survey. The specimens are mostly immature and I am supplying them to Dr. OBATA for a precise study of ontogeny. A topotype, GK. H4090, which T. OMORI kindly gave me, is nearly as large as the holotype. The following description is based on the holotype, the topotype, and other representative specimens, of which the illustrated ones are GK. H4089, GK. H4024, GK. H5544 and GK. H5545.

Diagnosis.—The shell is fairly small to moderate in size, being slightly over 100 mm. in the maximum diameter of the holotype, which is probably adult. The whorl is much compressed, much involute and narrowly umbilicate. This

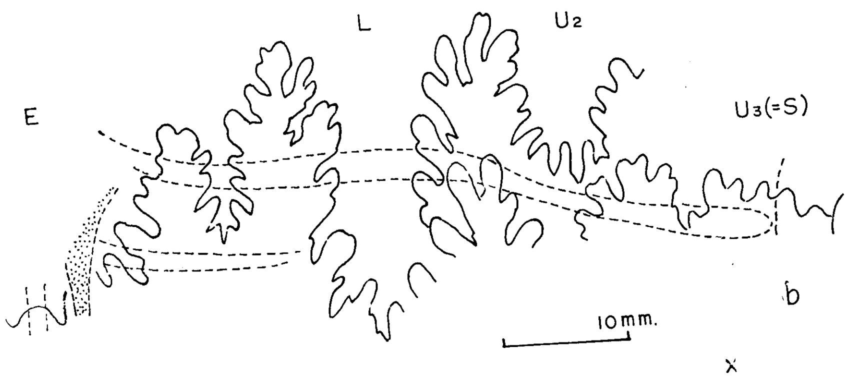


Fig. 34. *Reesidites minimus* (HAYASAKA and FUKADA).

a. Diagram of an adult shell in frontal view, restored from the holotype, from loc. Ik1003, Ikushumbets.
b. Last two sutures (partly unexposed) of the holotype, at whorl-height=c. 50 mm. E is secondarily modified by crossing of a calcite veinlet (dotted belt).

(T. M. *delin.*)

is especially distinct in comparatively late growth stages (see *Measurements*). The flanks are flattened and slightly convex, with the greatest whorl-breadth at the lower third of the height. The venter is very narrow and roof-shaped, with a distinctly serrate keel on the top. The ventrolateral shoulder is sloping. The umbilical wall is low but steep or nearly vertical, forming a subangular shoulder.

The ribs are numerous, crowded, separated by interspaces somewhat narrower than the ribs themselves. They spring in twos or threes from the umbilical bullae and shorter ribs are sometimes intercalated. They are sinuous on the flank; prorsiradiate near the umbilical margin, curved gently backward on the middle of the flank, being asymmetrically convex there, bent again more or less forward at a point somewhat below the ventrolateral shoulders, and then projected still more strongly forward on the venter, forming chevrons. On the outer whorl of the adult stage the forward bend of the ribs below the ventrolateral shoulder may become less distinct, but as a whole the ribs are still gently sinuous.

Every rib has a clavate tubercle at the ventrolateral shoulder and another clavus on the ventral keel. Each serration of the keel, thus, corresponds with each rib. It remains distinct up to the last stage of the outer whorl. On the last quarter whorl of the holotype the ribs are somewhat broadened but as elevated as those in the preceding stage and the ventrolateral clavi and umbilical bullae are also distinct. The ventrolateral tubercles are nearly three times as numerous as the umbilical

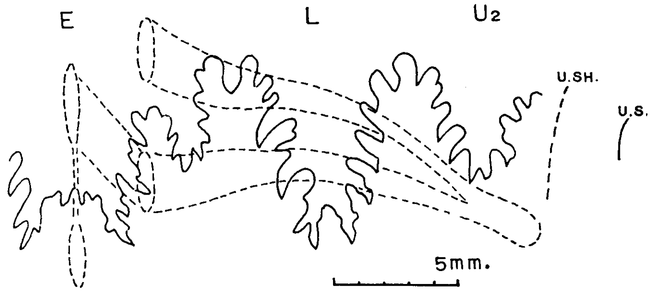


Fig. 35. *Reesidites minimus* (HAYASAKA and FUKADA). GK. H4090, a topotype nearly as large as the holotype. The last fifth suture at whorl-height=*c.* 25 mm. (T. M. *delin.*)

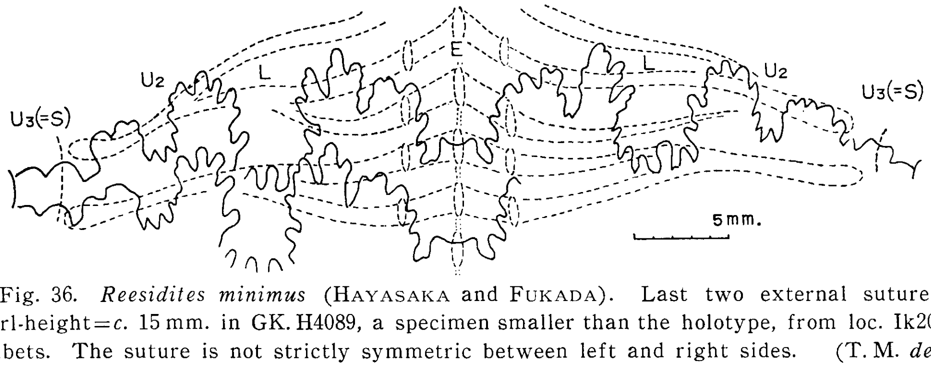


Fig. 36. *Reesidites minimus* (HAYASAKA and FUKADA). Last two external sutures at whorl-height=*c.* 15 mm. in GK. H4089, a specimen smaller than the holotype, from loc. Ik2013b, Pombets. The suture is not strictly symmetric between left and right sides. (T. M. *delin.*)

ones on the outer whorl; but the former may be about two and a half times as numerous as the latter on some inner whorls (see *Measurements*).

The ribs and tubercles normally begin to appear in the fifth whorl at a diameter of 8 mm. or so. The ribs are sinuous already in this stage. The siphonal keel and keel like trains of fine elevations at the ventrolateral shoulders may appear about a half-whorl earlier than that stage, although they are faint. There is a certain extent of variation from specimen to specimen in the fineness and density of the ribs, as in the proportion of the width of umbilicus to the shell diameter and that of the breadth to the height of the whorl.

The ornament in this species is generally very regular, without showing exaggeration.

On the lower part of the flank the larger ribs which spring directly from the umbilical bullae are somewhat more elevated than others, but on the upper part the ribs are of almost equal intensity and the ventral and ventrolateral clavi on the ribs are all moderately distinct. On the well preserved surface of the shell fine lirae may be seen on the ribs and interspaces. They are generally parallel to the ribs, but some ribs, especially the branched or intercalated ones, are in part oblique to them.

The suture consists of E, L, U_2, U_3 (=S), U_1, I, of which E is nearly as deep as or somewhat shallower than but always broader

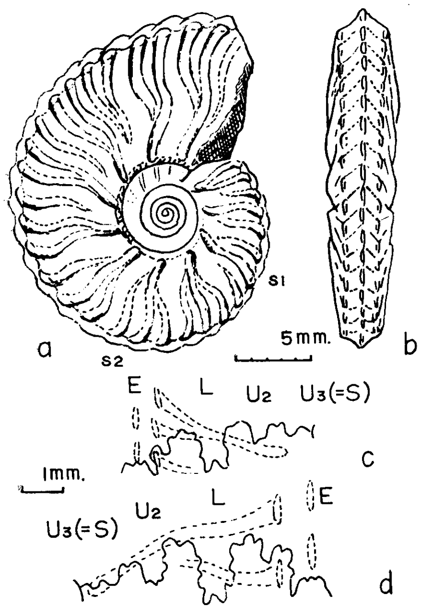


Fig. 37. *Reesidites minimus* (HAYASAKA and FUKADA). An example of the immature shell, GK. H4024, from loc. Ik946, Ikushumbets. Diagrammatic sketches in (a) lateral and (b) ventral views; (c) suture at s_1; (d) suture at s_2 in Fig. a.
(T. M. *declin.*)

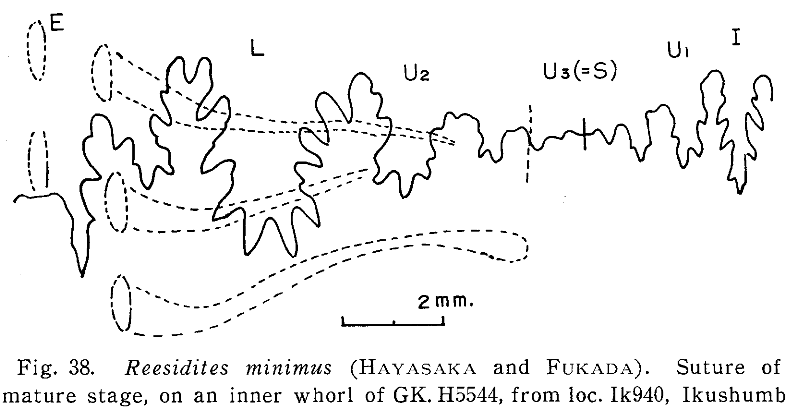


Fig. 38. *Reesidites minimus* (HAYASAKA and FUKADA). Suture of an immature stage, on an inner whorl of GK. H5544, from loc. Ik940, Ikushumbets.
(T. M. *delin.*)

than L. The saddle between E and L is deeply and obliquely divided; its branch on the side of L is erect and larger than that on the side of E. This character appears already in a young stage, with a whorl-height of 1.5 mm. Saddle are massive in general outline. Minor subdivisions of the saddles and lobes are less complex and not very deep. The second lateral saddle (between L and U_2) and the auxiliaries are arranged on a gently descending line. The elements of the internal suture are narrow. U_3 is subdivided at least twice in the middle growth-stage, and accordingly, three internal lobes are arranged on both sides of the deepest I, decreasing regularly in size toward the umbilical seam. In the holotype the last suture is seen at the shell diameter of about 100 mm. In another specimen, GK. H4090, it is at the diameter of 60 mm. and the living chamber occupies at least a half whorl. The apertural margin is not preserved in this specimen and in the holotype either.

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.	Involution	Tubercles Umb./Ventr.
Holotype	98.6(1)	16.2(0.16)	51.0(0.52)	22.8(0.23)	0.44	0.74	12/37
„ ($-\frac{1}{4}$ vol.)	86.0(1)	13.2(0.15)	46.0(0.53)	20.2(0.23)	0.44	—	—
GK. H4090	90.0(1)	15.6(0.17)	46.5(0.52)	17.4 (sec. deform.)		0.77	12/36
„ ($-\frac{1}{2}$ vol.)	—	—	32.2	14.3	0.44	—	
GK. H4089	53.5	r. 11.1(0.20) l. 10.4(0.19)	27.8(0.52)	[deformed]	—	0.66	13/42
„ ($-\frac{1}{3}$ vol.)	36.2	r. 7.5(0.20) l. 6.6(0.19)	18.4(0.51)	9.3(0.25)	0.50	0.61	12/32
GK. H4024	21.6(1)	5.2(0.24)	10.2(0.47)	4.8(0.22)	0.47	0.50	—
GK. H5545	8.4(1)	2.6(0.31)	3.4(0.40)	2.1(0.25)	0.62		

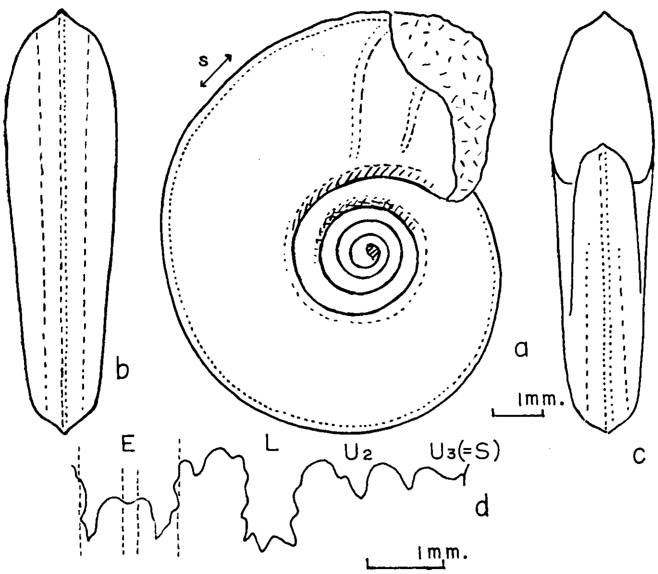


Fig. 39. *Reesidites minimus* (HAYASAKA and FUKADA). An infant shell, GK. H5545, from loc. Ik939, Ikushumbets. (a) Lateral view; (b) ventral view; (c) frontal view (restored); (d) suture at whorl-height =3.0 mm. (T. M. *delin.*)

Remarks.—As OBATA is studying the allometry of the present species, I omit to give precise description of ontogeny and variation on this occasion.

Affinities.—*Reesidites minimus* is most closely allied to *Subprionocyclus normalis* (ANDERSON) (see preceding description and MATSUMOTO, 1959c). They are very similar to each other in the early immature stage up to, for instance, about 15 mm. in diameter. In the late immature stage (or "middle growth-stage"), they are fairly similar, but on the average of the variation, *R. minimus* is more compressed, more narrowly umbilicate, and provided with more numerous and denser ribs, and accordingly, more numerous outer (i. e. ventrolateral and ventral) clavi than *S. normalis*. As regards the number of umbilical tubercles no remarkable difference is seen between the two species. The clearest distinction is in that *S. normalis* in this stage has a row of lower ventrolateral tubercles on the ribs but *R. minimus* is free from them and only shows a bending of the ribs at the corresponding position. In the late growth-stage the lower ventrolateral tubercles disapper even from *S. normalis*, but other differences as enumerated above become more distinct. In the pattern of the suture the two species closely resemble.

Because *R. minimus* occurs in the stratigraphic unit immediately above the bed with *S. normalis* in the sequence of the Ikushumets and beceuse they are so closely allied to each other as explained above, *R. minimus* most probably evolved from *S. normalis*.

It is interesting to note that the sinuous dense ribbing without lower ventrolateral tubercles in *R. minimus* is fairly similar to that in some young inner whorls of *Subprionocyclus neptuni* (described above) of about 10-25 mm. diameters. The former species is, however, more involute, more narrowly umbilicate and more compressed than the immature shell of the latter species.

It cannot be overlooked, at the same time, that the smoothish but weakly keeled very young whorl, with a diameter of several millimeters, of *R. minimus* (and also *S. normalis*) looks surprisingly similar to middle aged shell of *Paralenticeras spathi* REYMENT, although the latter is more narrowly umbilicate.

Barroisiceras haberfellneri (VON HAUER) 1866, p. 2, pl. 1, figs. 1-5; REDTENBACHER, 1873, p. 101, pl. 23, fig. 2a-d), from the Coniacian of the Alpine Gosau beds, is the type-species of *Barroisiceras* DE GROSSOUVRE, as originally designated. This species was subsequently redescribed clearly by BASSE (1947, p. 114) and REYMENT (1959b, p. 45, pl. 9, fig. 2; pl. 12, fig. 2a-b; text-fig. 6-2). As compared with *Reesidites minimus*, *Barroisiceras haberfellneri*, in a revised sense, has the whorls much more thickened around the umbilical margin, a fewer number of stronger, sometimes mammillate, umbilical tubercles, less numerous, non-flexuous, nearly radial or gently convex, broader ribs and generally simpler sutures in which the first lateral saddle (between E and L) is not modified as in that species. The ribs tend to be reduced in some grown shells of *B. haberfellneri*, but the ribbing is kept distinct up to the end of the last whorl in *R. minimus*. HAYASAKA and FUKADA (1951, p. 327) said of the holotype that its "surface ornamentation tends to become smooth toward the aperture", but this does not conform with the actual character of the holotype. The apparent smoothing is a secondary erosion or polishing on a portion of one side of the specimen.

BASSE has shown a great range of variation of *Barroisiceras onilahyense* BASSE (1947, p. 100, pls. 1-5; pl. 6, figs. 1-4; pl. 7, fig. 1, 1a; pl. 8, figs. 1-2; text. figs. 1-3), from Madagascar. *Reesidites minimus*, which shows much smaller extent of variation, is distinguished from *B. onilahyense* by almost the same criteria as those between it and *B. haberfellneri*. It is distinguishable even from a relatively compressed and finely costate variety of that Madagascar species (e. g. BASSE, 1947, pl. 6, fig. 4, 4a) by its more numerous and flexuous ribs and its particular pattern of suture.

On the grounds of above observations, I am rather inclined to conclude that *Reesidites minimus* did not directly give rise to any species of *Barroisiceras*.

Reesidites subtuberculatus (GERHARDT) (1897, p. 156, pl. 3, fig. 12; REYMENT, 1958a, p. 10, pl. 1, figs. 4-5; pl. 2, figs. 1a, b, 2; text-fig. 4a), from Colombia and Venezuela, is less compressed and has weaker umbilical tubercles, a smaller number of ribs and weaker serration of a ventral keel than *R. minimus*.

A set of specimens of *Reesidites* from the upper reaches of the Haboro in W. HASHIMOTO's collection resembles the present species but may be distinct, because it has a more compressed whorl and more numerous ribs. A full description of this species is to be deferred on another occasion.

Occurrence.—Loc. Ik1003, type-locality, which was the cliff along a forestry railway in the Ikushumbets valley, about 200 m. below the confluence of the Ban-no-sawa, a tributary, with the main stream. The exposed strata are greenish-bluish gray fine sandy siltstone and silty fine sandstone containing richly fossiliferous, calcareous nodules. Their stratigraphic position lies between the First and the Second Green-sandstones in the upper part of Member IIIa, lower part of the Upper Yezo Group in the sequence on the eastern wing of the Ikushumbets anticline and is in the upper part of the zone of *Inoceramus teshioensis*. The same strata were exposed at locs. Ik938, Ik946 and Ik967 on the river floor and banks of the meandering main stream of the Ikushumbets and the specimens were obtained in abundance there. Regretfully these localities, including the type-locality, were all submerged under the artificial lake of the Katsurazawa dam since October, 1957. The same *Reesidites* bearing strata are at present exposed at loc. Ik1188, on the right side of the Katsurazawa dam. This place is, however, unfavourable for hunting fossils. At loc. Ik2013b, an exposure on the right side of the Pombets, about 35 m. stratigraphically below the green sandstone in the lower part of the Upper Yezo Group on the western wing of Ikushumbets anticline, I obtained only a single specimen of this species from a nodule in dark gray fine-sandy siltstone, upper part of the zone of *Inoceramus teshioensis*.

A few more examples were found at loc. Yb41a, b, near the top of Member Mk4, Mikasa Sandstone Formation, in the upper part of the same zone of *Inoceramus teshioensis* in the Yubari dome (see MATSUMOTO and HARADA, 1964), about 25 km. south of Ikushumbets. The species is said to occur likewise in the Manji dome between Yubari and Ikushumbets, but I have not examined in detail the stratigraphy there.

The specimen from loc. T40-41p2, Saku-Gakko-zawa may be referable to this species. Other specimens previously listed as *R. minimus* from loc. T670, Saku Formation in the Saku area, Teshio province, are immature *Subprionocyclus neptuni*

(GEINITZ).

Genus *Niceforoceras* BASSE, 1948

Type-species.—Niceforoceras columbianum BASSE, 1948 by original designation.

Generic diagnosis.—The shell is comparatively small, consisting of rapidly growing involute whorls, and narrowly umbilicate. The whorl is much higher than broad, especially in the late growth-stage, with a narrow, obtusely roof-shaped or subrounded venter, sloping shoulders, flat or slightly inflated flanks. The siphonal keel is narrow, low, and almost smooth, or faintly serrate, with the serration corresponding to each rib. The test is thin.

The flank of the whorl is ornamented with fine, weak, flexiradiate ribs, which start from the bullae at the umbilical margin, bifurcated there or with inserted secondaries. The ribs end at the outer ventrolateral clavi which are situated fairly close to the keel but separated from it by a shallow furrow or a depressed narrow area. In addition to the outer clavi weak inner ventrolateral tubercles may be discernible in some species. Fine lirae cover the surface of the shell; they show on the venter obtuse chevrons, crossing the keel. The ornaments are much weakened in the adult stage.

The suture is incompletely known in the type-species. That observed in a Japanese species has the general pattern of the Collignoniceratinae. The saddle between E and L is asymmetrically bipartite. The auxiliaries are descending but not very numerous.

Remarks.—BASSE established *Niceforoceras* for several species from the Coniacian of Colombia, but she did not discuss much about its systematic position. A species from Japan to be described below resembles *Reesidites* in the absence of inner ventolateral tubercles, but it may not be a typical *Niceforoceras*. One of the species from Colombia, i.e. *Schloenbachia subtuberculata* GERHARDT (1897, p. 156, pl. 3, fig. 12a, b), which was at one time referred to *Niceforoceras* by BASSE, has recently been transferred to *Reesidites* by REYMENT (1958, p. 10). GERHARDT recorded the occurrence of the holotype (by monotypy) of this species as " Das Stück trug die Etiquette: Velez, und sein Gestein ist dasselbe, in welchem die Barreme-Pulchellien stecken " and this gives us some trouble. On the grounds of the subsequent collection in Sedgwick Museum, Cambridge, REYMENT concluded the age of this species as Coniacian, without discussing much the stratigraphy. RIEDEL's specimen from the so-called Lower Cretaceous of the Cordillera Oriental (RIEDEL, 1938, pl. 10, fig. 1) was reproduced by BÜRGL (1957, pl. 16, fig. 1a, b, c) as a " Lower Coniacian *Barroisiceras subtuberculatum*." This may be indeed a *Barroisiceras*, but it does not seem to be specifically identical with GERHARDT's holotype. I think that the South American Cordillera in Colombia, Venezuela and Peru are important field for the study of the Cretaceous ammonites. The zone by zone sequence of various species, their morphological variations, and their interspecific relations should be more carefully worked out there.

Be that as it may, *Niceforoceras* resembles *Reesidites*, but is distinguishable by its weaker ribs, only faintly serrate or almost smooth, smaller, siphonal keel. *N.*

columbianum BASSE (1948, p. 694, pl. 25, fig. 2), the type-species of *Niceforoceras*, is described as possessing inner ventrolateral tubercles in addition to the outer clavi, although the character is not distinctly illustrated on the plate. If this is truly so, this species can be regarded as a direct descendant from *Subprionocyclus* with weakening of the ribs and keel, although no linking species has been known.

I would agree with WRIGHT *in* MOORE [Ed.] (1957, p. L435) and REYMENT (1958) in the interpretation that *Paralenticeras* HYATT, 1900, is probably a smoothed derivative of a *Niceforoceras*, with a modification in sutures. In this connection sutures of *Niceforoceras* have to be carefully studied. *Niceforoceras* is indeed important for the linking of the Collignoniceratinae with the Lenticeratinae, but taxonomic and stratigraphic sorting is still needed for the so-called *Niceforoceras* and related genera.

The species from Japan, to be described below, may be one of the so-called *Niceforoceras*, because it differs to some extent from the type-species. It is, however, an interesting species in that it shows a similarity to a species of *Reesidites*.

Distribution.—*Niceforoceras* has been known from the Coniacian of Colombia and Venezuela. Its wider distribution is suggested by the occurrence of its probable representative in Hokkaido.

Niceforoceras (?) *japonicum* sp. nov.

Pl. 11, Fig. 1; Text-fig. 40

Material.—Holotype, GK.H5495, from loc. JPE. 12, Kumaoi-zawa, a right tributary of the upper course of the Ikushumbets, Ishikari province, Hokkaido (Coll. Japan Petroleum Exploration, donated to Kyushu University). No other specimens have yet been found.

Diagnosis.—The shell is small and thinly discoidal, consisting of moderately involute whorls; about a half of the inner whorl is overlapped by the outer one. The whorl is compressed, increasing more rapidly in height than in breadth. The umbilicus is moderately narrow and surrounded by a low and nearly vertical wall; the umbilical shoulder is subangular in costal section and subrounded in intercostal section. The flanks are gently inflated in the immature stage, tending to be nearly flat, with a slight inflation, in the late stage, and somewhat convergent, with the maximum whorl-breadth in the lower part. The venter is narrow and gently arched, passing to sloping shoulders. The siphonal keel is narrow, low, smooth and bordered by shallow grooves. It is already developed on the subrounded young whorl of about 6 mm. in diameter.

The bullae begin to appear around the umbilical margin when the shell diameter is about 8 mm. The first three bullae are weak and not much extended radially, then the bullae become considerably strong from which spring the faint, flexuous ribs, singly or in pairs. About 12 umbilical bullae are in a whorl of about 15 mm. diameter. In the early part of this stage, which include the first five umbilical bullae, the ribs fade away as they approach the venter, without forming marginal tubercles. In the succeeding stage, with shell-diameter over 12 mm., the flexuous ribs are very weak on the flank but again moderately elevated and somewhat broadened as they approach the ventrolateral part where they are projected and end at the outer ventrolateral clavi, which are fairly close to the keel, separated by a shallow furrow.

On the outer whorl the umbilical bullae, as well as the ribs, are considerably crowded: There are 36 ribs in a whorl, of which 18 are primaries, starting from the umbilical bullae. The ribs sometimes bifurcate at the umbilical bullae and sometimes single, with intercalated ones starting somewhat above the umbilical margin. When the test is preserved fine lirae cover the surface of the shell in parallel to ribs and interspaces. On the venter the lirae are extended from the ventrolateral clavi across the furrows and the keel, forming obtuse chevrons.

In the holotype the last septum is about the diameter of 24 mm. The ornamentation of the body-whorl is similar to that of the late part of the septate whorl, but the ribs are very faint and the outer ventrolateral tubercles are also weak on the body-whorl. Umbilical bullae are, however, moderately strong, as far as the preserved posterior part of the body-whorl is concerned.

The suture is of the general *Collignoniceras* pattern, consisting of E, L, U_2, U_3 [=S], U_1, and I. E is the largest of the lobes; L is moderately deep, subrectangular in a rough outline; U_2 is much small, U_1 is as narrow and as deep as U_2; I is narrow and deep. The saddle between E and L is massive and asymmetrically divided, with a further subdivided, broader, external branch, and consequently it is apparently

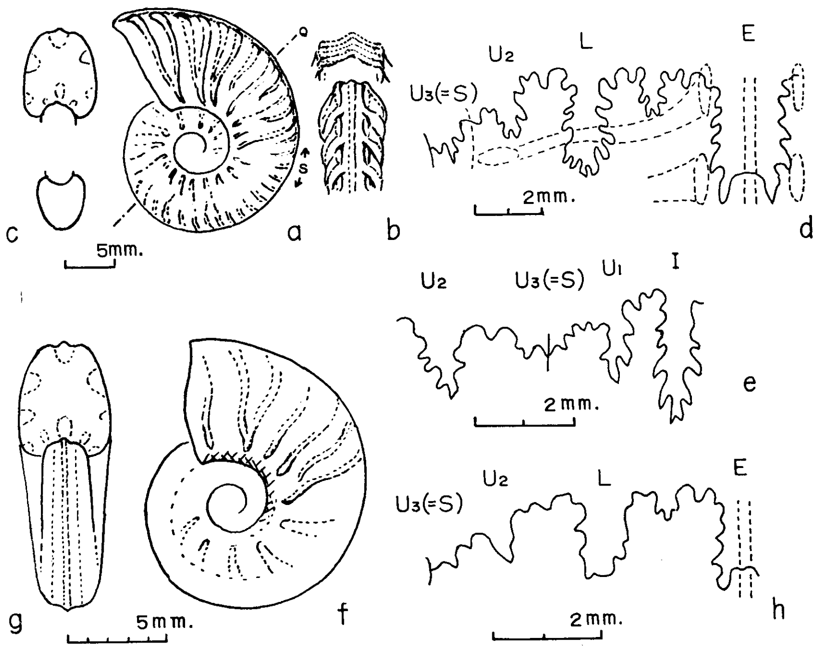


Fig. 40. *Niceforoceras* (?) *japonicum* sp. nov. Holotype GK. H5495, from loc. JPE. 12, Kumaoi-zawa, Ikushumbets, diagrammatic sketches. (a) Lateral view; (b) part of venter; (c) whorl-section at Q in Fig. (a); (d) external suture at whorl-height=7 mm.; (e) internal suture at almost the same stage; (f) inner whorl in lateral view; (g) inner whorl in frontal view; (h) external suture of the inner whorl. (T. M. *delin.*)

tripartite. Auxiliary saddles are descending and not numerous. Minor incisions are rather small and shallow. Folioles are somewhat phylloid in aspects.

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
GK. H5495	24.4(1)	6.6(0.28)	11.4(0.46)	8.5(0.35)	0.74
„ (−½ vol.)	20.2(1)	5.6(0.28)	9.2(0.45)	7.2(0.35)	0.78

Remarks.—It is indeed regretable that only a single specimen is at present available for this species, but the holotype itself is well preserved, showing diagnostic features. The extent of variation is not known.

Affinities.—The present species somewhat resembles *Niceforoceras columbianum* BASSE (1948, p. 694, pl. 25, fig. 2), the type-species of this genus, from Colombia, in the moderate involution, gently arched, instead of roof-shaped, venter, gently flexuous, fine ribs, etc., but it is devoid of inner ventrolateral tubercles which are described as occurring in *N. columbianum* and its ventral keel is entire and not serrate as in that species.

This species resembles to some extent *Schloenbachia flexuosa* GERHARDT (1897, p. 157, pl. 4, fig. 1), from the Coniacian of Colombia, which is probably an example of *Niceforoceras* as BASSE (1948) pointed out. It can be distinguished by its broader whorl, less involution, wider umbilicus, less remarkably flexuous ribs, much stronger umbilical bullae, less acutely projected ventral lirae and a more gently arched, instead of a roof-shaped, venter than that species from Colombia.

Schloenbachia boreaui DE GROSSOUVRE (1894, p. 111, pl. 7, fig. 3a, b), from the middle Coniacian of France, is apparently similar to the present species. Without seeing the original specimen, I hesitate to decide whether that species from France is referable to *Niceforoceras*, or to *Pseudobarroisiceras*, or otherwise. From the description, however, it seems to be an example of *Pseudobarroisiceras*, as SHIMIZU (1932) thought, because the ribs are elevated at the ventrolateral shoulder and then inclined strongly forward. In the present species the ribs terminate at the outer ventrolateral clavae, without forming tubercles at the inner ventrolateral bend. The ribs in the Japanese species are nearly as numerous as and as flexuous as those in the French species, but they are weaker on the flank than in the latter. The French species has more involute whorls and narrower umbilicus than ours. Unfortunately the pattern of suture is unknown in the French species. If that species was truly referable to *Pseudobarroisiceras*, more numerous auxiliaries could be seen in its suture, as in *Pseudobarroisiceras nagoi* SHIMIZU (1932, p. 3, pl. 1, figs. 6–8).

It is interesting to find some resemblance between the present species and *Reesidites minimus* (described above), from the Upper Turonian of Hokkaido, in the absence of inner ventrolateral tubercles. The latter species has a fastigate venter and a serrate keel and the ribs are extended from the outer ventrolateral clavi, forming chevrons on crossing the keel, in which each serration corresponds to each rib. *R. minimus* is characterized by a more involute, more narrowly umbilicate and more compressed shell and has stronger ribs than the present species. It has modified sutures as described above.

Finally it may be noted that the present species is apparently similar to some species of *Submortoniceras* in the shell-form, weakened ornament on the flank, fairly distinct umbilical bullae and ventral clavi on both sides of a smooth mid-ventral keel. *Submortoniceras* has, however, five rows of tubercles in certain growth-stages and belongs to the Texanitinae. The similarity is nothing but a homoeomorphy.

Occurrence.—Loc. No. 12 of J. P. E. in the Kumaoi-zawa, a right tributary of the upper reaches of the Ikushumbets, Hokkaido.

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Tatsuro MATSUMOTO

A Monograph of the Collignoniceratidae from Hokkaido

Part I

Plates 1—18

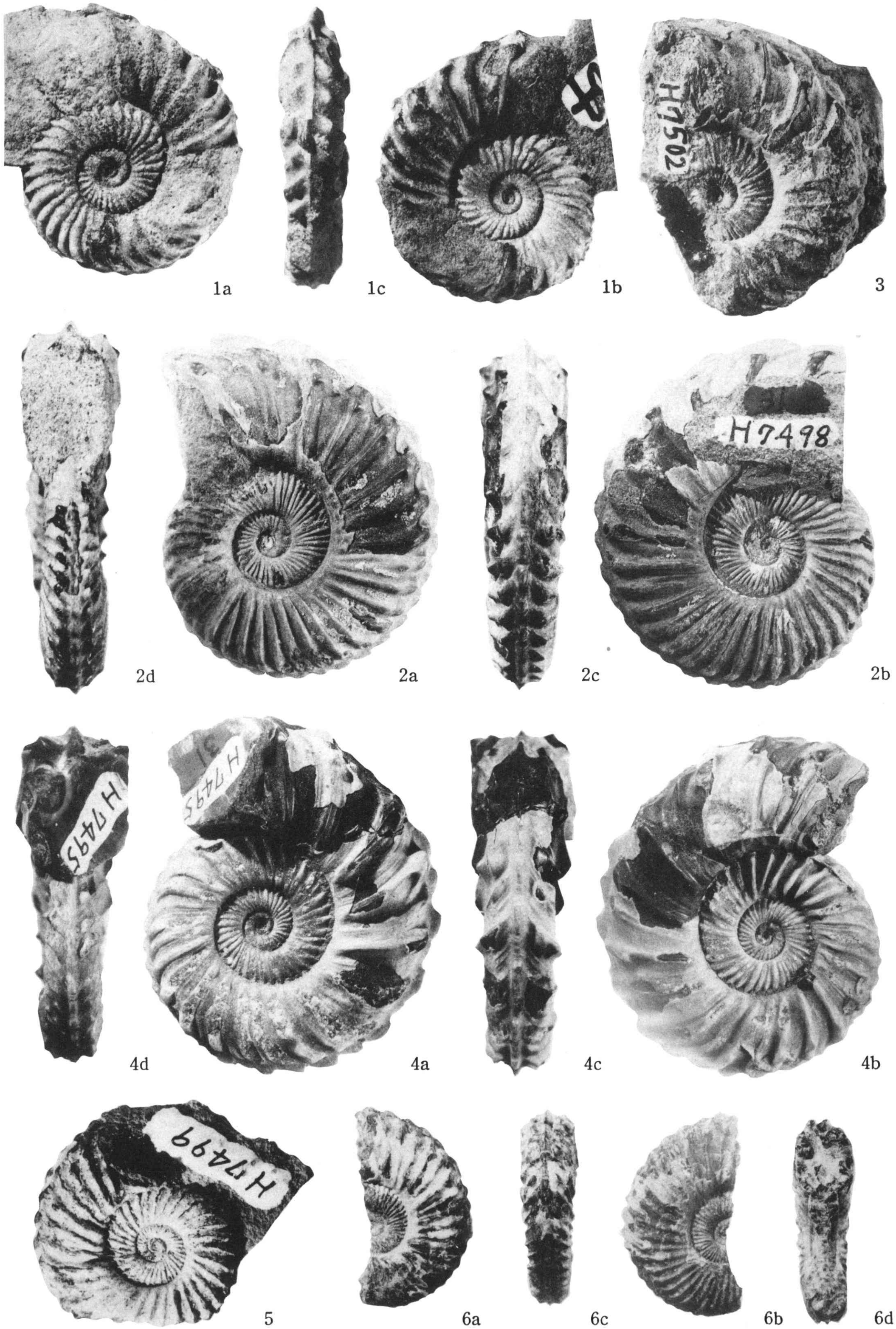
Plate 1

Explanation of Plate 1

Figs. 1-6. *Collignoniceras woollgari* (MANTELL) .... Page 11

Representative examples of various subgroups in the variable species from one and the same locality TM. 31, 2 miles southwest of New Castle, Wyoming, Carlile Shale, about 30 feet above the base (Coll. T. MATSUMOTO, under the guidance of Dr. W.A. COBBAN) (to be continued to Plate 2).

1. GK.H7504 (internal mould), two lateral (a, b) and ventral (c) views, ×5. An example of Group A in the text.
2. GK.H7498, two lateral (a, b), ventral (c) and frontal (d) views, ×2. An example of Group B.
3. GK.H7502, lateral view, ×2. Another example of Group B.
4. GK.H7495, two lateral (a, b), ventral (c) and frontal (d) views, ×2. An example of Group C.
5. GK.H7499, lateral view, ×2. An example of Group D.
6. GK.H7453c, two lateral (a, b), ventral (c) and frontal (d) views, ×2. An immature specimen probably referable to Group E.



T. MATSUMOTO: Collignoniceratidae

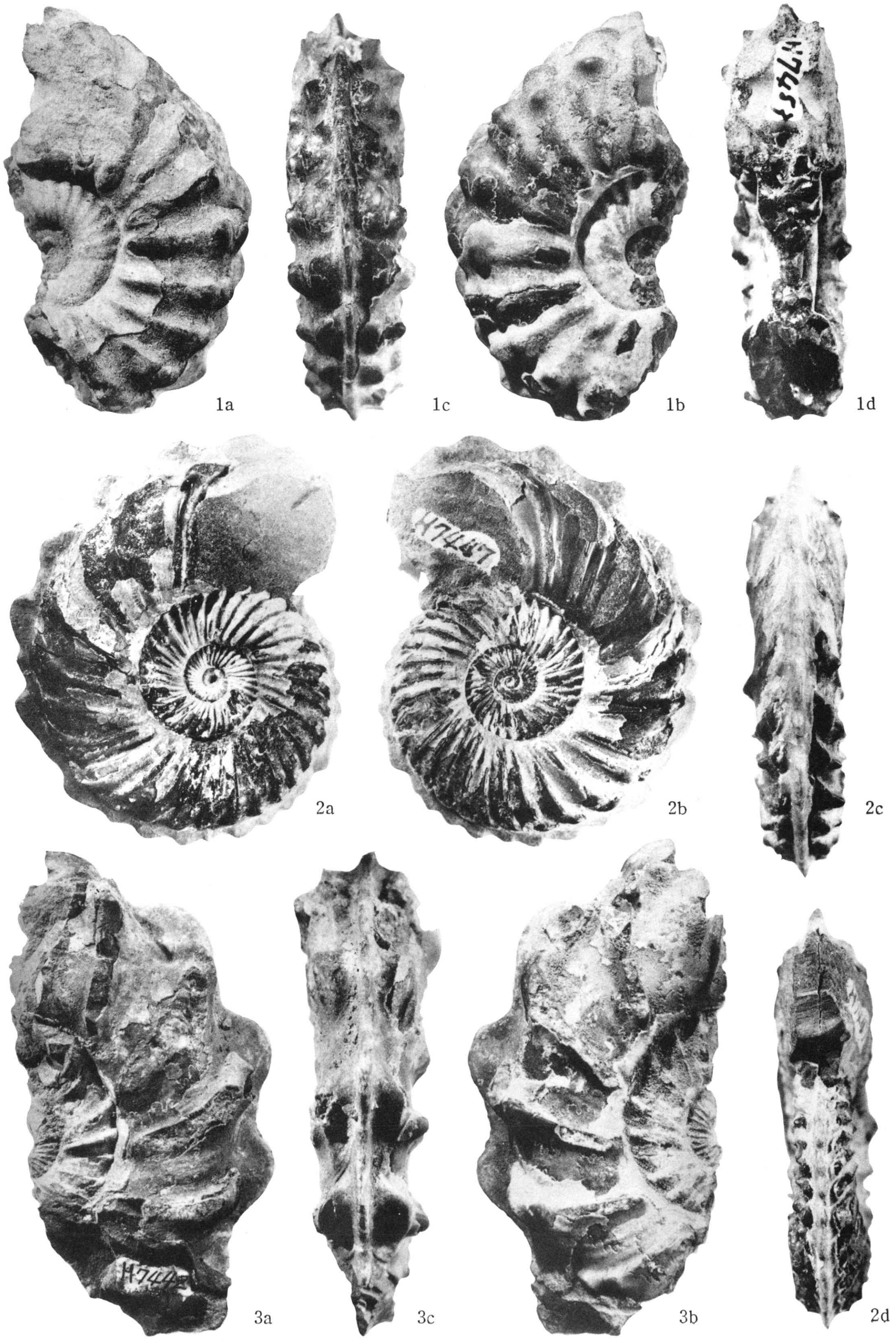
Plate 2

Explanation of Plate 2

Figs. 1–3. *Collignoniceras woollgari* (MANTELL) .... Page 11

Representative examples of various subgroups of the variable species from one and the same locality TM. 31, 2 miles southwest of New Castle, Wyoming, Carlile Shale, about 30 feet above the base (Coll. T. MATSUMOTO, under the guidance of Dr. W.A. COBBAN) (continued from Plate 1).

1. GK.H7453a, two lateral (a, b) and ventral (c) views; natural cross section (d), ×2. An example of Group E in the text.
2. GK.H7447, two lateral (a, b), ventral (c) and frontal (d) views, ×2. A typical example of Group B.
3. GK.H7442, two lateral (a, b) and ventral (c) views, ×2. An example showing the adolescent stage of Group B. This closely resembles one of MEEK's specimens (1876, pl. 7, fig. la, b).



T. Matsumoto: Collignoniceratidae

Plate 3

Explanation of Plate 3

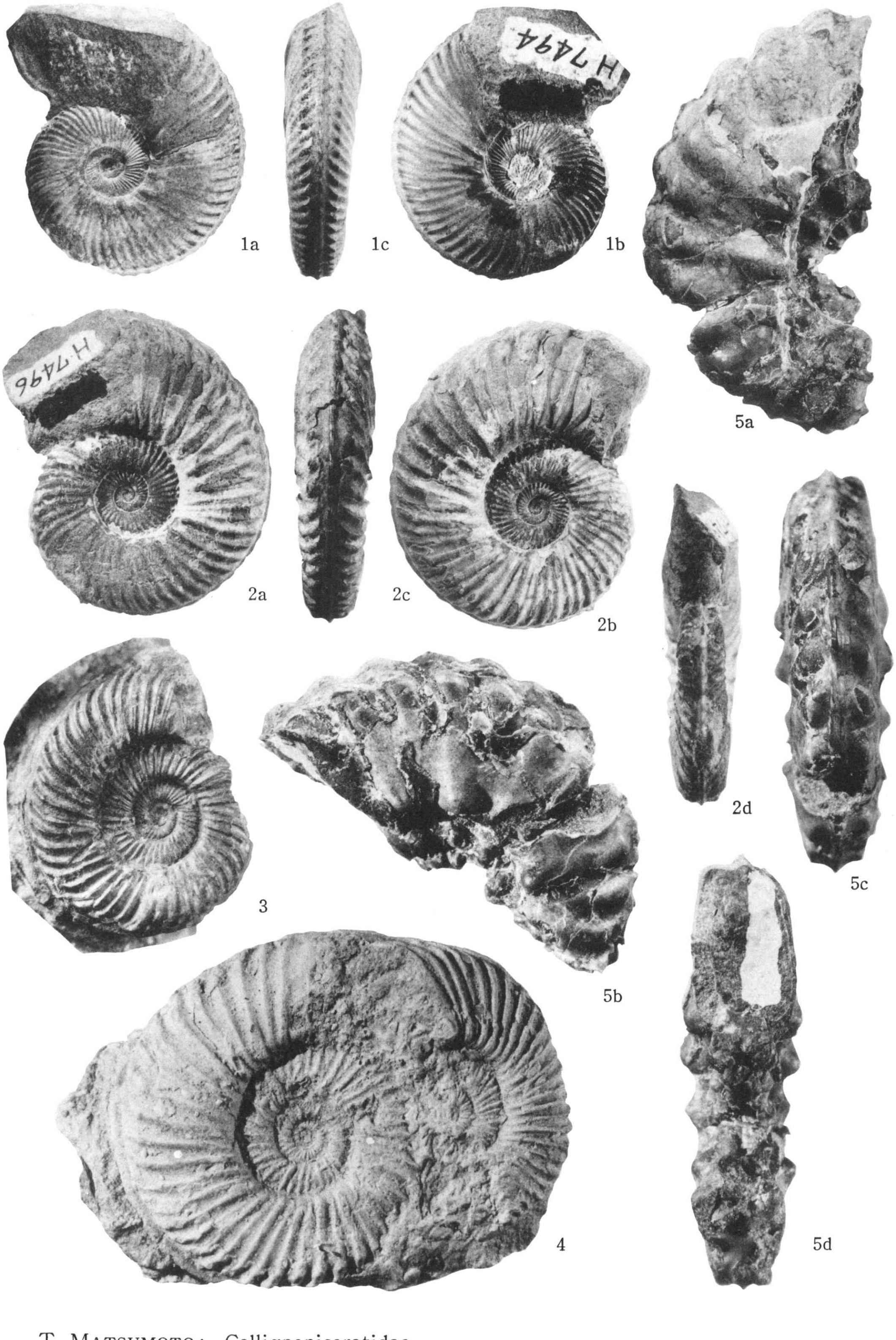
Figs. 1, 2. *Collignoniceras woollgari* (MANTELL) ....Page 11
Representatives of various subgroups in the variable species from one and the same loc. TM. 31, 2 miles southwest of New Castle, Wyoming, Carlile Shale, about 30 feet above the base (Coll. T. MATSUMOTO, under the guidance of Dr. W. A. COBBAN) (continued from Pls. 1-2).

1. GK.H7494, two lateral (a, b) and ventral (c) views, ×2. An example of Group F.
2. GK.H7496, two lateral (a, b), ventral (c) and frontal (d) views, ×2. An example of Group D.

Figs. 3, 4. *Collignoniceras woollgari bakeri* (ANDERSON) ....Page 16

3. GK.H5481, from loc. T1022 P7, Saku-gakko-zawa. Saku Formation (IId) of Saku area, Teshio province (Coll. T. MATSUMOTO). Lateral view, ×2.
4. GK.H9116, plaster cast of the lectotype from Oregon. Lateral view, ×2.

Fig. 5. *Subprionocyclus neptuni* (GEINITZ) ....Page 52
GK.H5532, from loc. Ik2016a, the Pombets, a tributary of the Ikushumbets (Coll. T. MATSUMOTO). Two lateral (a, b), ventral (c) and frontal (d) views, ×2.



T. Matsumoto: Collignoniceratidae

Plate 4

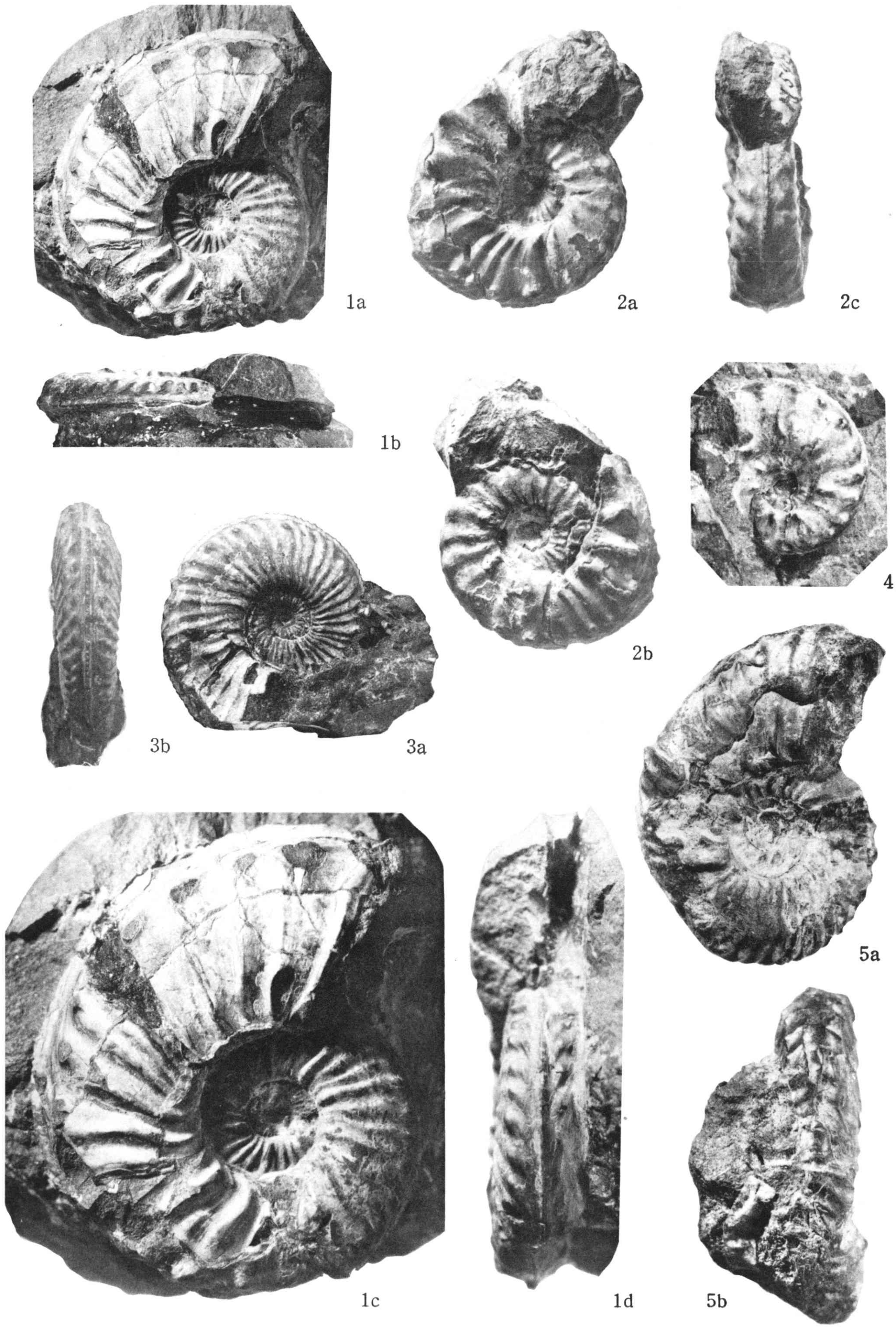
Explanation of Plate 4

Figs. 1-4. *Prionocyclus cobbani* sp. nov .... Page 21

1. Holotype, GK.H5432, from loc. Ik2012, the Pombets, zone of *Inoceramus tenuistriatus* -*I. teshioensis* (Coll. T. MURAMOTO, P.2217). Lateral (a) and frontal (b) views, ×1; lateral (c) and frontal (d) views, ×2.
2. Paratype, GK.H5480, from loc. Ik2012c, the Pombets (Coll. T. MURAMOTO). Two lateral (a, b) and frontal (c) views, ×1. A less compressed and coarsely ribbed example.
3. Paratype, GK.H5433, from loc. Ik2012c, the Pombets (Coll. T. MURAMOTO). Lateral (a) and ventral (b) views, ×10/7. A compressed and finely ribbed example.
4. Paratype, GK.H5431, from loc. Ik2012c, the Pombets (Coll. T. MURAMOTO). Lateral view, ×10/7.

Fig. 5. *Subprionotropis muramotoi* sp. nov .... Page 47

Holotype, GK.H5434, from loc. Ik2012c, the Pombets (Coll. T. MURAMOTO). Lateral (a) and ventral (b) views, ×2.

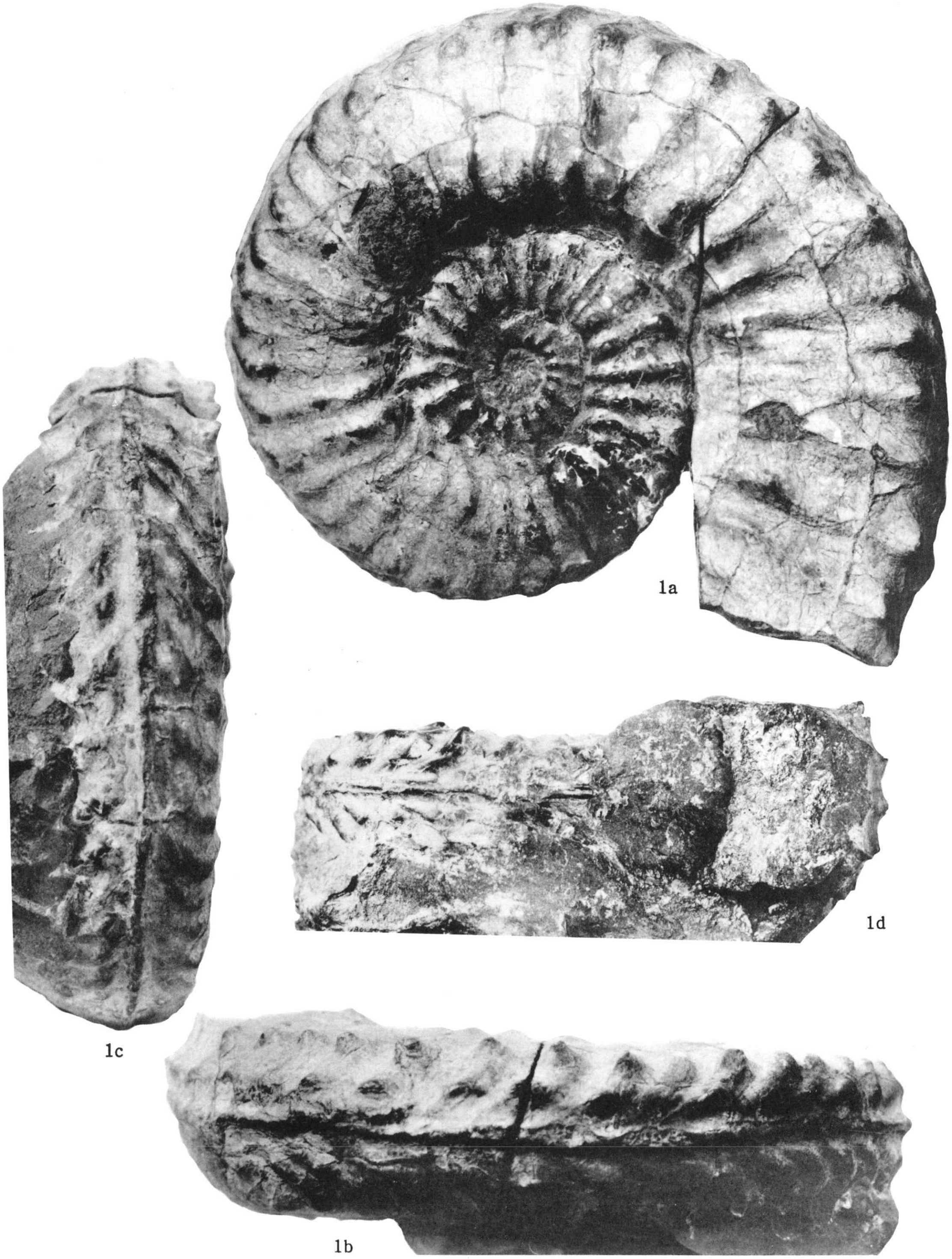


T. MATSUMOTO : Collignoniceratidae

Plate 5

Explanation of Plate 5

Fig. 1. *Prionocyclus aberrans* sp. nov .... Page 25
Holotype, Hokkaido Univ. Coll. 12006, from Pombets, zone of *Inoceramus tenuistriatus* -*I. teshioensis* (Coll. GOTO, presented to the University through R. SAITO). (a) Lateral view. (b, c, d) Ventral views of body-whorl (b), transitional part (c) and septate, inner whorl (d), ×1.



T. MATSUMOTO: Collignoniceratidae

Plate 6

Explanation of Plate 6

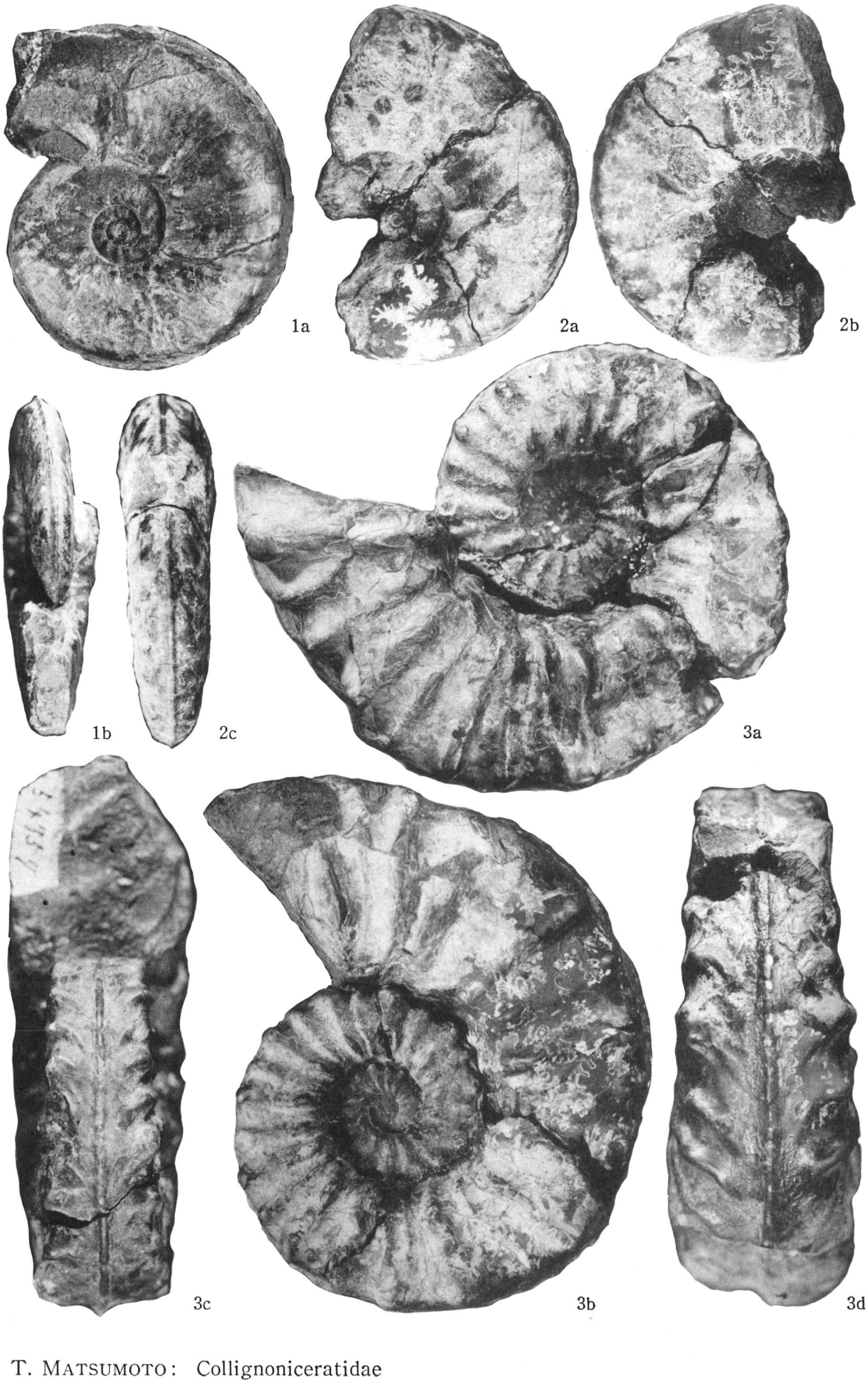
Figs. 1, 2. *Lymaniceras planulatum* gen. et sp. nov .... Page 31

1. IGPS. 56892 A, from Pombets (Tohoku Univ. Coll.). Lateral (a) and frontal (b) views, $\times 1$. A rather compressed example with smoothish body-whorl. This is one of the specimens which were labelled as *Prionocycloceras ezoense* SHIMIZU, MS., *nom. nud.*
2. IGPS. 36834, from Pombets (Tohoku Univ. Coll.). Two lateral (a, b) and ventral (c) views, $\times 1$. This was labelled as *Prionocyclus imbecilluscostatus* SHIMIZU MS., *nom. nud.*

Fig. 3. *Prionocyclus aberrans* sp. nov .... Page 25

Paratype, IGPS. 54757, from Pombets (Tohoku Univ. Coll.). Two lateral (a, b), frontal (c) and ventral (d) views, $\times 1$. This was labelled as *Gauthiericeras shibatai* SHIMIZU, MS., *nom. nud.*

Tohoku University Photos.



T. MATSUMOTO: Collignoniceratidae

Plate 7

Explanation of Plate 7

Figs. 1–5. *Lymaniceras planulatum* gen. et sp. nov .... Page 31

1. Holotype, GK.H5430, from loc. Ik2012c, the Pombets, zone of *Inoceramus tenuistriatus -I. teshioensis* (Coll. T.MURAMOTO). Two lateral (a, b), ventral (c) and frontal (d) views, ×3/2.
2. Paratype, GK.H5465, from loc. Ik2012c (Coll. T. MURAMOTO, P. 2218). Two lateral (a, b), ventral (c) and frontal (d) views, ×2. An immature example.
3. Paratype, GK.H5467a, from loc. Ik2012c (Coll. T. & K. MURAMOTO). Lateral view, ×2.
4. Paratype, GK.H5476, from loc. Ik2012c (Coll.T. MURAMOTO, P2218). Lateral (a) and ventral (b) views, ×2.
5. Paratype, GK.H5474, from loc. Ik2012c (Coll. T. MURAMOTO, P2270). Two lateral (a, b) and ventral (c) views, ×2.

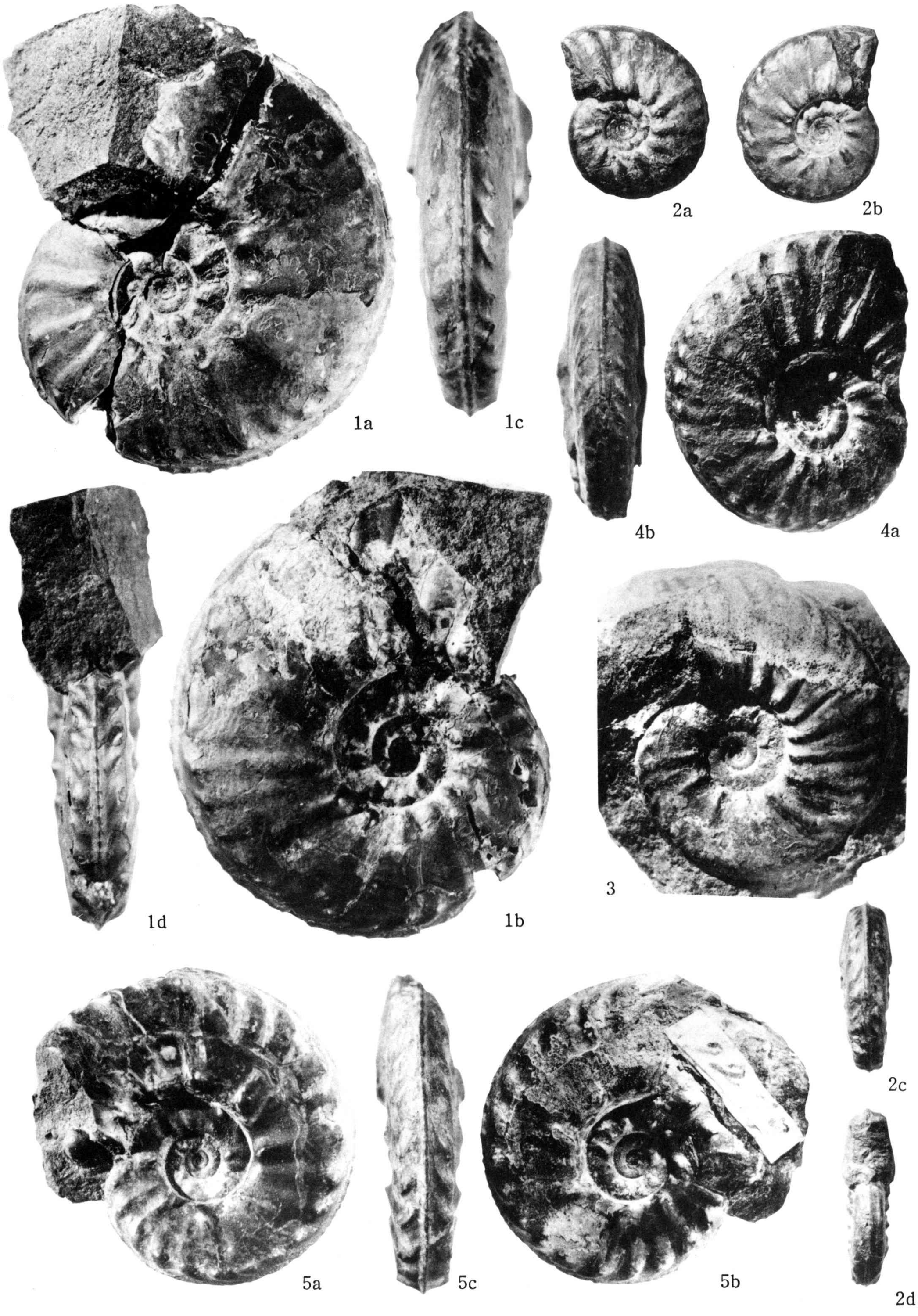
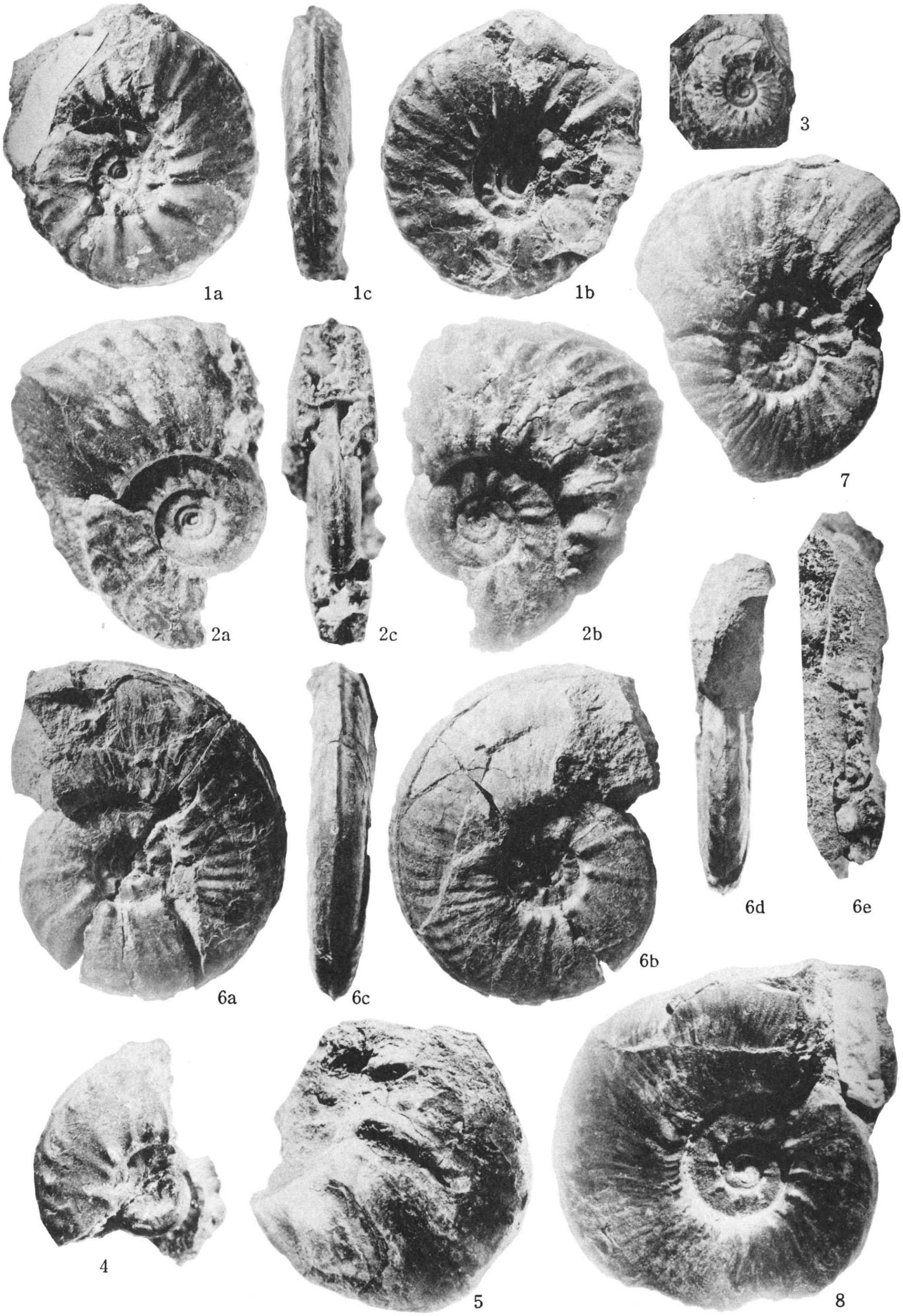

1a
1c
2a
2b
4b
4a
1d
1b
3
2c
5a
5c
5b
2d

Plate 8

Explanation of Plate 8

Figs. 1-8. *Lymaniceras planulatum* gen. et sp. nov ....Page 31

1. Paratype, GK.H5466, from loc.Ik2012c, the Pombets, zone of *Inoceramus tenuistriatus -I. teshioensis* (Coll. T. MURAMOTO, P2218). Two lateral (a, b) and ventral (c) views, ×2.
2. Paratype, GK.H5429a, from loc. Ik2012c, the Pombets (Coll. T. MURAMOTO, 482). Two lateral (a, b) and ventral (c) views of the inner whorl with natural sections of the outer whorl, ×3. An example in which the ontogenic development is observable (see also Text-fig. 14).
3. Paratype, GK.H5429b, from loc. Ik2012c, the Pombets (Coll. T. MURAMOTO, 482). Lateral view of an immature specimen, ×1.
4. Paratype, GK.H5527, from loc. B223, upper reaches of the Bibai (Coll. K. TANAKA). Lateral view (×3) of an immature specimen in which very early stages of ontogeny are observable (see also Text-fig. 13).
5. Paratype, GK.H5475, from loc. Ik2012c, the Pombets (Coll. T. MURAMOTO, P2218). Lateral view of a fragmentary body-whorl, ×1.
6. Paratype, GK.H5528, from a small branch of the Pombets (Coll. K. TANAKA). Two lateral (a, b), ventral (c) and frontal (d) views and natural cross section (e) of a comparatively compressed example, which has a weakly costate body-whorl, ×1.
7. Paratype, GK.H5468, from loc. Ik2012c, the Pombets (Coll. T. MURAMOTO). Lateral view, ×2. An example which has a densely and weakly costate outer whorl.
8. Paratype, GK.H5472, from loc. Ik2012c, the Pombets, (Coll. T. MURAMOTO P2240). Lateral view, ×2. An example which is densely and finely costate on the outer whorl and nearly laevigate on the outermost part.

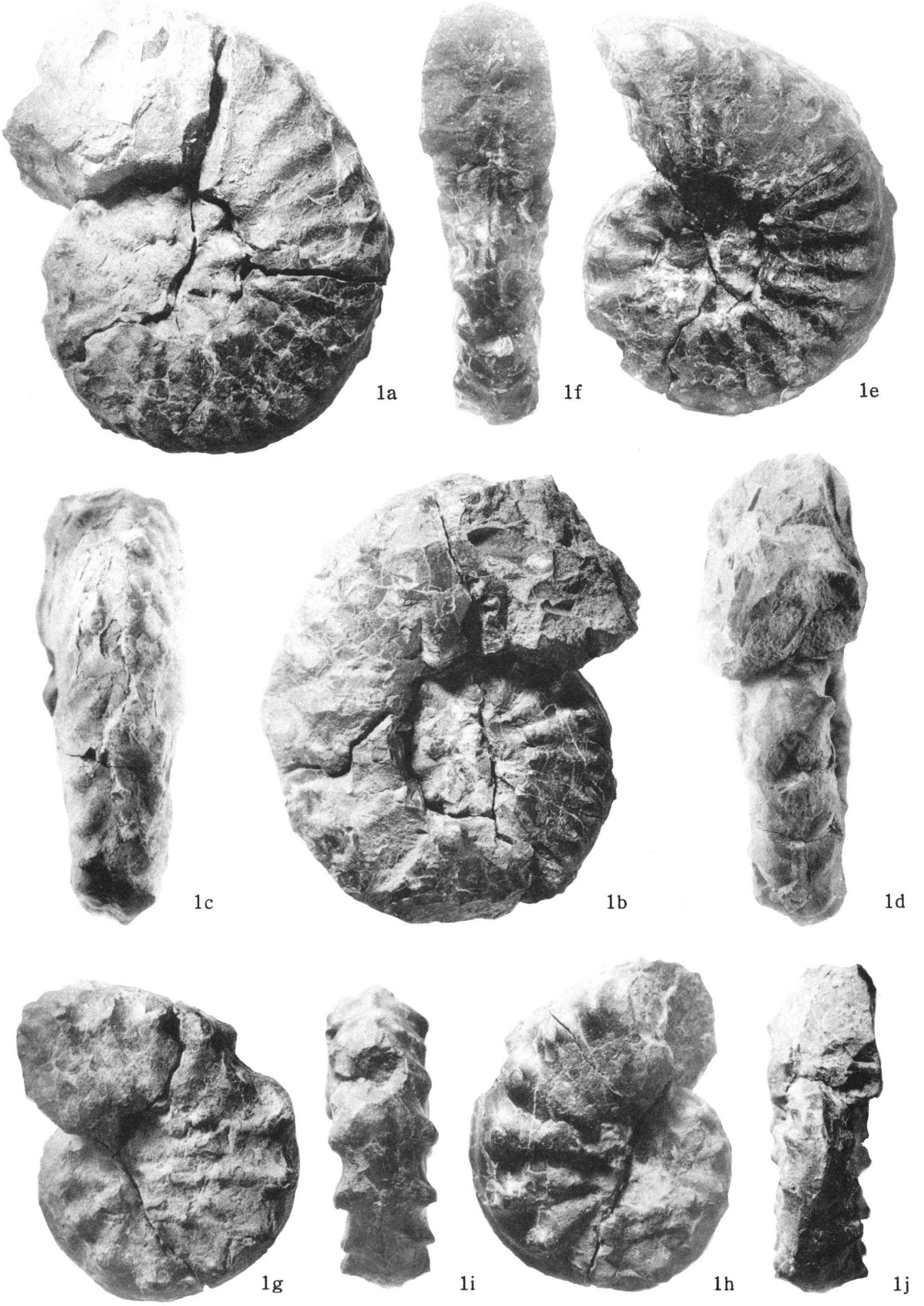


T. MATSUMOTO: Collignoniceratidae

Plate 9

Explanation of Plate 9

Fig. 1. *Prionocycloceras sigmoidale* sp. nov .... Page 4
Holotype, GK.H5435, from Ban-no-sawa (close to Ik 1111), a tributary of the Ikushumbets, Member IIIb, zone of *Inoceramus uwajimensis* (Coll. T. MURAMOTO, 2001). Two lateral (a, b), ventral (c) and frontal (d) views, $\times 1$; lateral (e) and frontal (f) views, $\times 1$, of the same specimen from which the outermost portion is removed; two lateral (g, h), ventral (i) and frontal (j) views of the inner whorl, $\times 3/2$.



T. MATSUMOTO: Collignoniceratidae

Plate 10

Explanation of Plate 10

Figs. 1, 2. *Prionocycloceras sigmoidale* sp. nov ....Page 41

1. A deformed, secondarily compressed specimen, Mikasa High School Coll., from the upper reaches of the Ichi-no-sawa ("Oku-futa-mata"), probably derived from Member IIIb. Two lateral (a, b) and ventral (c) views, ×1.
2. A fragmentary body-whorl, Mikasa High School Coll., No. 108, from the Ichi-no-sawa, a tributary of the Ikushumbets, Member IIIb, zone of *Inoceramus uwajimensis*. Two lateral (a, b) and ventral (c) views, ×1.

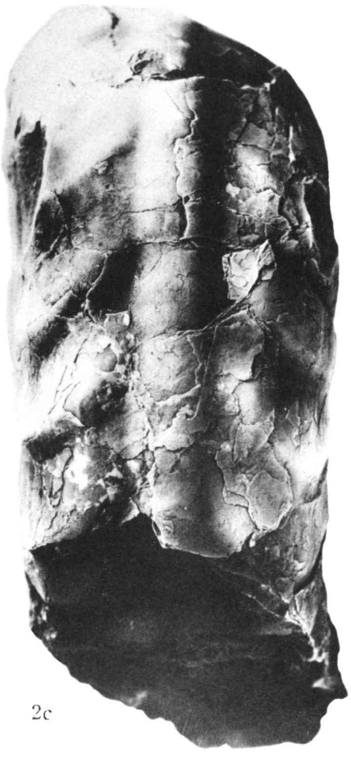
1c

1a

2a

1b

2b



2c

T. MATSUMOTO: Collignoniceratidae

Plate 11

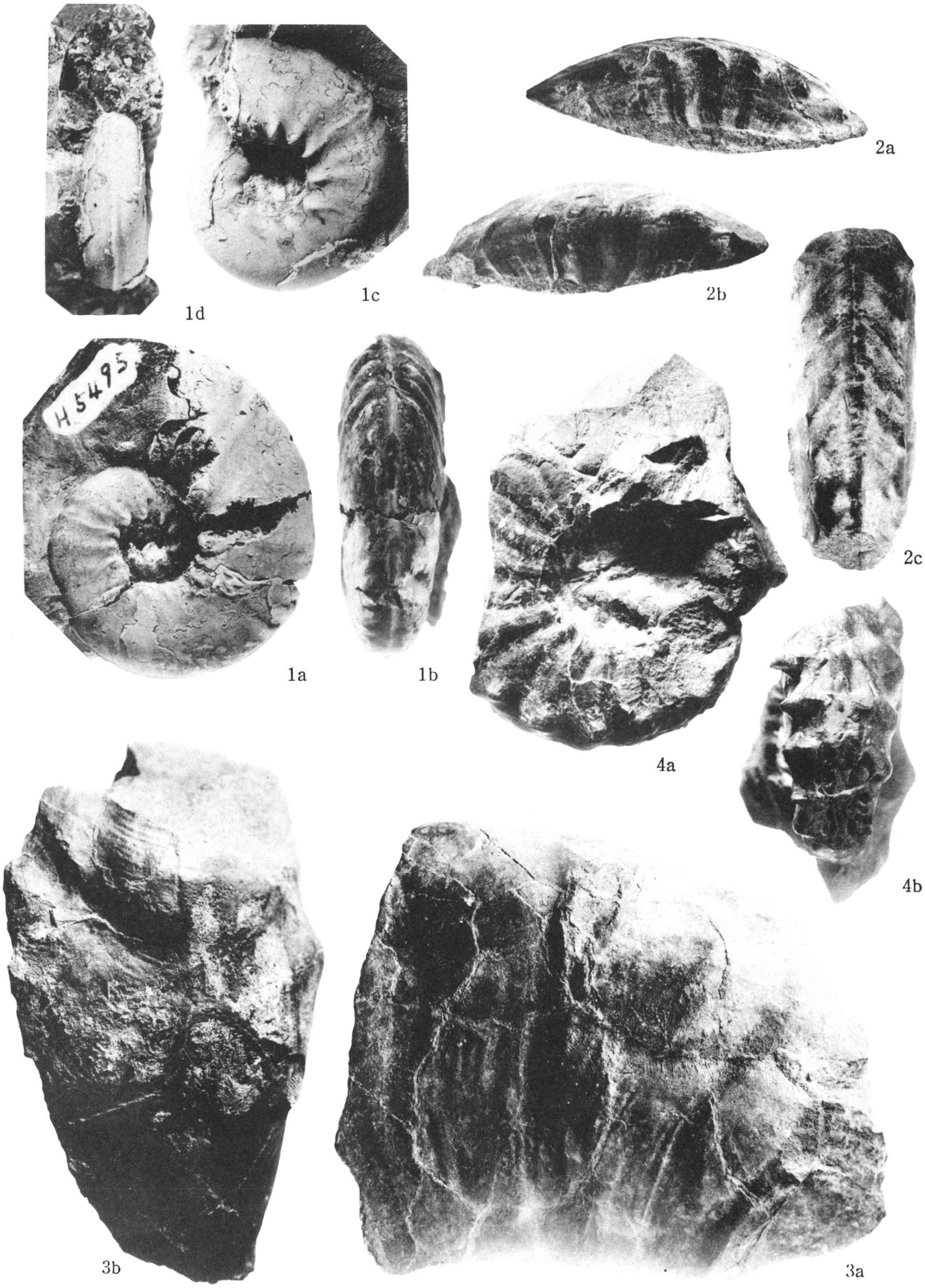
Explanation of Plate 11

Fig. 1. *Niceforoceras* (?) *japonicum* sp. nov..Page 71
Holotype, GK.H5495, from loc. JPE. 12, Kumaoi-zawa, a tributary of the Ikushumbets (Coll. IWAMOTO). Lateral (a) and ventral (b) views, ×2; lateral (c) and frontal (d) views of the inner whorl, ×3.

Figs. 2, 3. *Prionocycloceras* sp. aff. *P. lenti* (GERHARDT) ....Page 45

2. GK.H5489, from loc. Ik 1110b, Ban-no-sawa, a tributary of the Ikushumbets, Member IIIb, zone of *Inoceramus uwajimensis* (Coll. T. MATSUMOTO). Two lateral (a, b) and ventral (c) views, ×1. A fragmentary smaller, probably immature, whorl.
3. GK.H5492, from loc. Ik 1111a, Ban-no-sawa, the same member and zone (Coll. T. MATSUMOTO). Lateral (a) and ventral (b) views, ×1. A fragmentary body-whorl.

Fig. 4. *Prionocycloceras* sp. aff. *P. guayabanum* (STEINMANN)........................Page 43
GK.H5436, from Kami-ichi-no-sawa, a tributary of the Ikushumbets, Member IIIb, lower part of the Upper Yezo Group (Coll. T. & K. MURAMOTO). Lateral (a) and ventral (b) views, ×1.



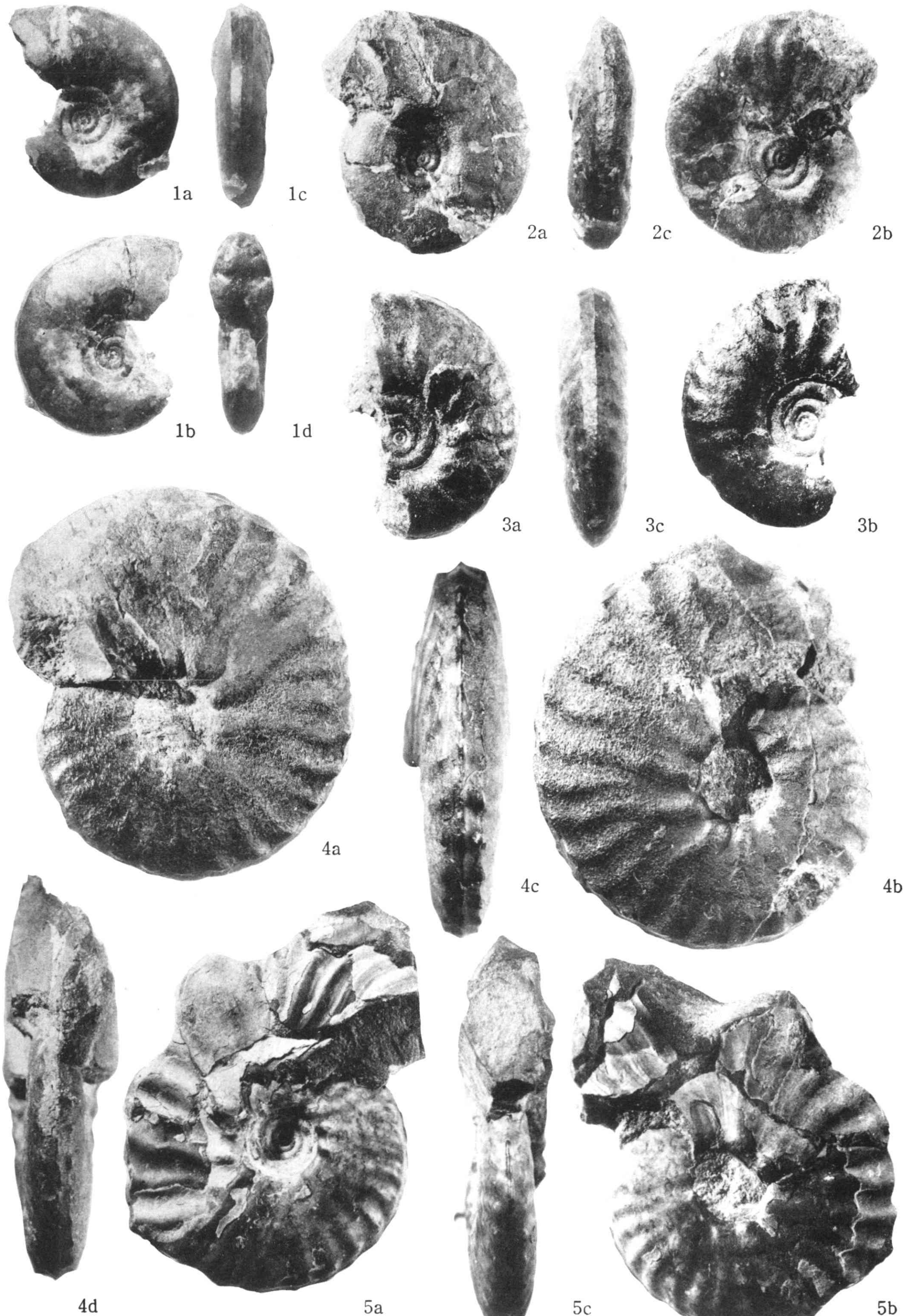
T. Matsumoto: Collignoniceratidae

Plate 12

Explanation of Plate 12

Figs. 1-5. *Subprionocyclus normalis* (ANDERSON) ....Page 55

1. GK.H7061a, from loc. TM.2001=LSJU. 3288, Little Cow Creek, Member III of the Redding area, California (Coll. T. MATSUMOTO, under the guidance of Dr. W.P. POPENOE). Two lateral (a, b), ventral (c) and frontal (d) views, ×4. An example of the infant stage.
2. GK.H5496, from loc Ik971, First Greensandstone in Member IIIa, zone of *Inoceramus teshioensis*, Ikushumbets (Coll. T. MATSUMOTO). Two lateral (a, b) and ventral (c) views, ×4.
3. GK.H5499b, from loc. Ik 1181, First Greensandstone in Member IIIa, zone of *Inoceramus teshioensis*, Ikushumbets (Coll. T. MATSUMOTO). Two lateral (a, b) and ventral (c) views, ×4. Another infant shell.
4. GK.H5499a. from loc. Ik 1181, Greensandstone in Bed IIIa, zone of *Inoceramus teshioensis*, Ikushumbets (Coll. T. MATSUMOTO). Two lateral (a, b), ventral (c) and frontal (d) views, ×2. An example of the middle growth-stage.
5. GK.H5202, NAGAOKA's Collection from an uncertain locality in Teshio (?). Two lateral (a, b) and frontal (c) views, ×2.



T. MATSUMOTO: Collignoniceratidae

Plate 13

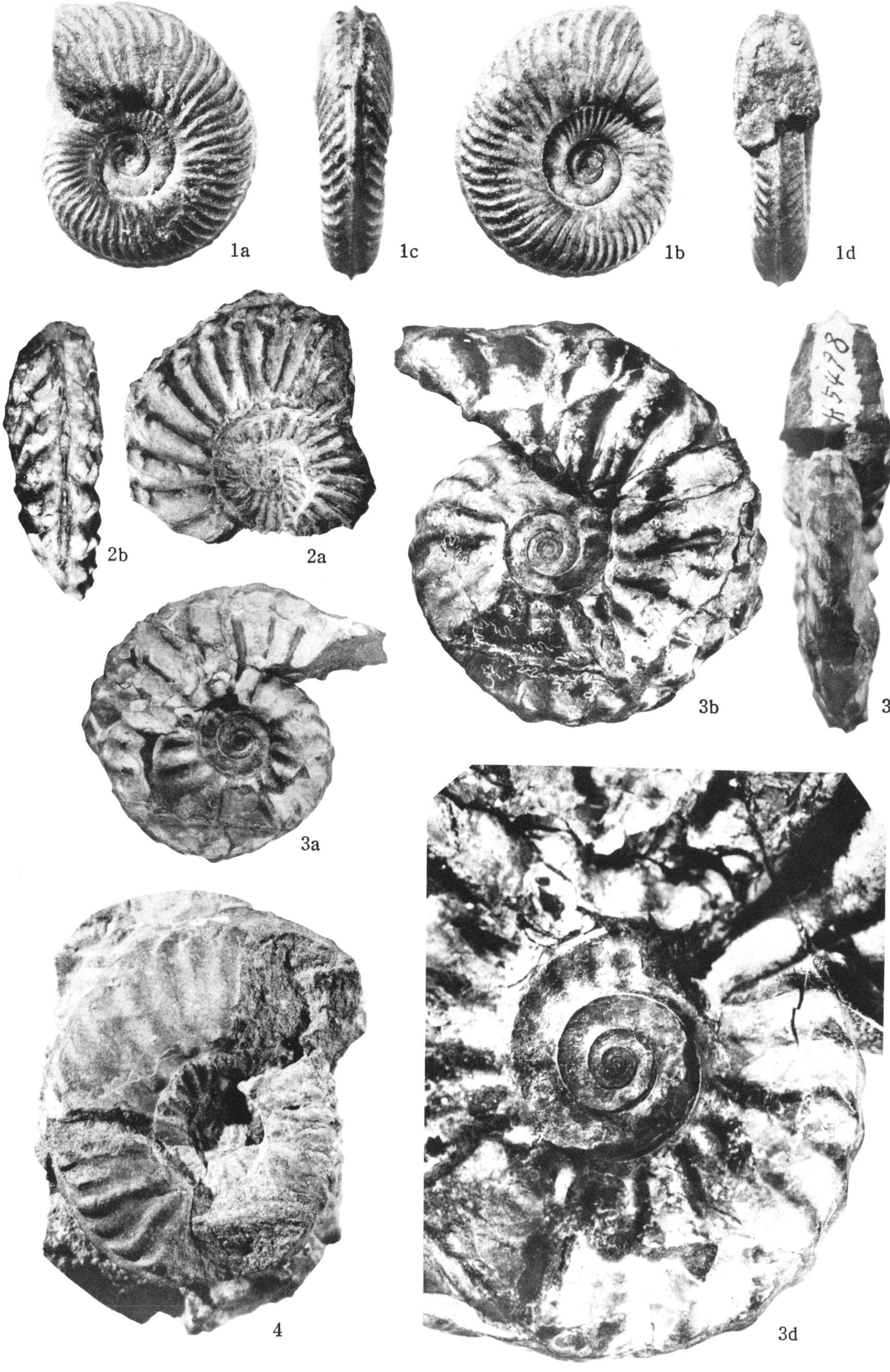
Explanation of Plate 13

Fig. 1. *Subprionocyclus neptuni* (GEINITZ) ....Page 52
GK.H1501a, from loc. Y132-4, Member IIs, upper part of the Saku Formation, Shuyubari valley (Coll. T. MATSUMOTO). Two lateral (a, b), ventral (c) and frontal (d) views, ×4. Am immature specimen (internal mould).

Fig. 2. *Subprionocyclus branneri* (ANDERSON)..Page 50
IGPS. 8027a, from Obirashibets, the holotype of *Prionotropis teshioensis* YABE and SHIMIZU. Lateral (a) and ventral (b) views, ×1.

Fig. 3 *Subprionocyclus normalis* (ANDERSON) ....Page 55
GK.H5498, from loc. Ik2014, lower part of Member IIIa, Pombets (Coll. YOSHIMOTO, a student of Mikasa High School). Lateral (a), ×3/2, the other side (b) and frontal (c) views, ×2. Lateral view of inner whorls (d), ×4.

Fig. 4. *Subprionocyclus neptuni* (GEINITZ) ....Page 52
GK.H5542, from loc. Yb 36p, Yubari dome, Member Mk 4 (Coll. M. HARADA). Lateral view, ×2.



T. MATSUMOTO: Collignoniceratidae

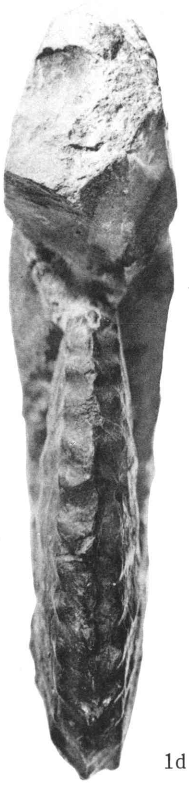
Plate 14

Explanation of Plate 14

Fig. 1. *Reesidites minimus* (HAYASAKA and FUKADA).......................................Page 63
Holotype from loc. Ik 1103, Ikushumbets, Hokkaido University Collection. Two lateral (a, b), ventral (c) and frontal (d) views, $\times 1$.

1a

1c



1d

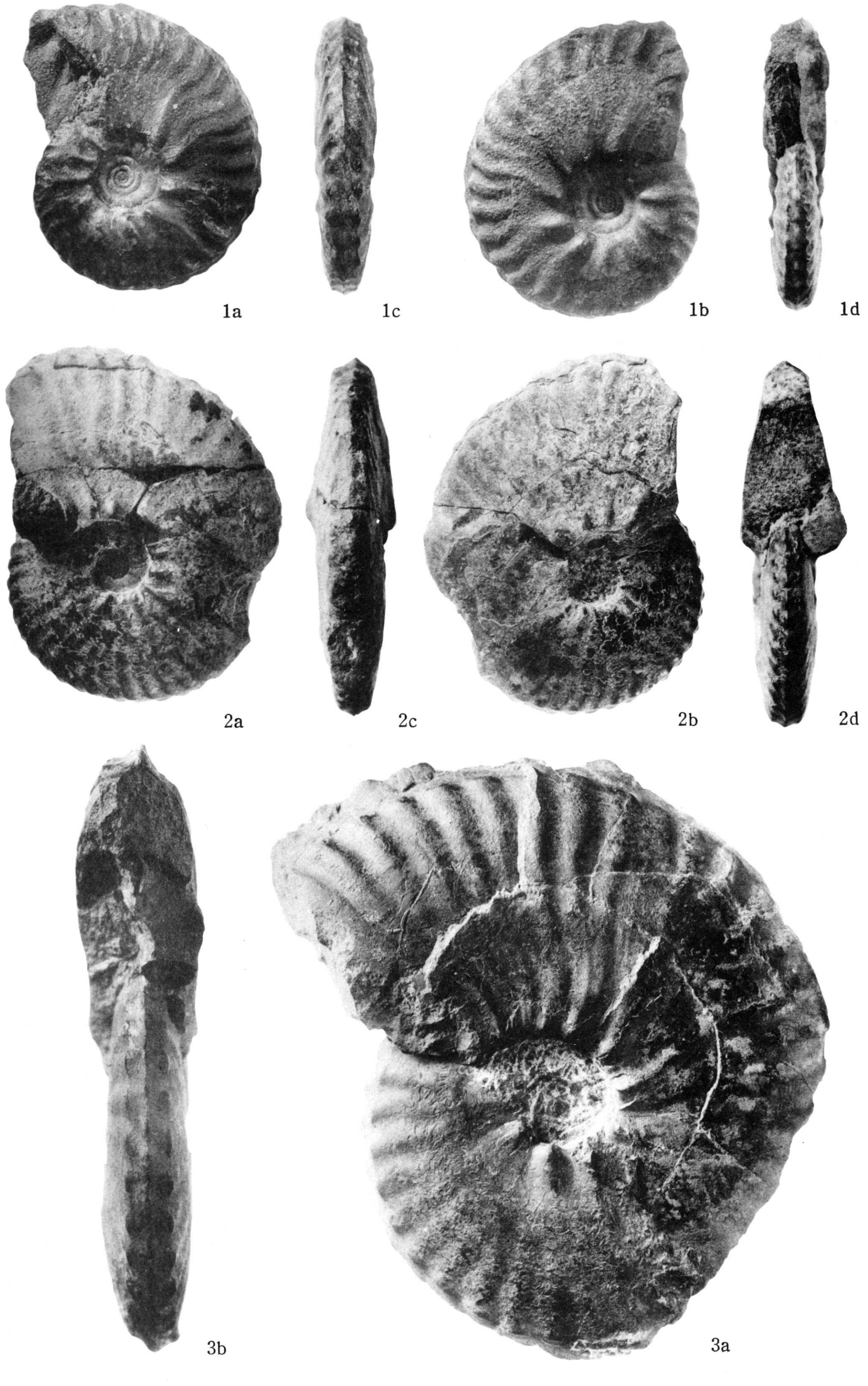
1b

Plate 15

Explanation of Plate 15

Figs. 1-4. *Reesidites minimus* (HAYASAKA and FUKADA) ....Page 63

1. GK.H4024, from loc. Ik 946, the Ikushumbets, subzone of *Reesidites minimus* (Coll. T. MATSUMOTO). Two lateral (a, b), ventral (c) and frontal (d) views, $\times 2$. Immature specimen.
2. GK.H4089, from loc. Ik2013b, the Pombets (Coll. T. MATSUMOTO). Two lateral (a, b), ventral (c) and frontal (d) views, $\times 1$. Body-whorl is secondarily compressed.
3. GK.H4090, from loc. Ik1103, the Ikushumbets (Coll. T. OMORI). Lateral (a) and frontal (b) views, $\times 1$. A topotype, nearly as large as the holotype. The body-whorl is secondarily deformed.

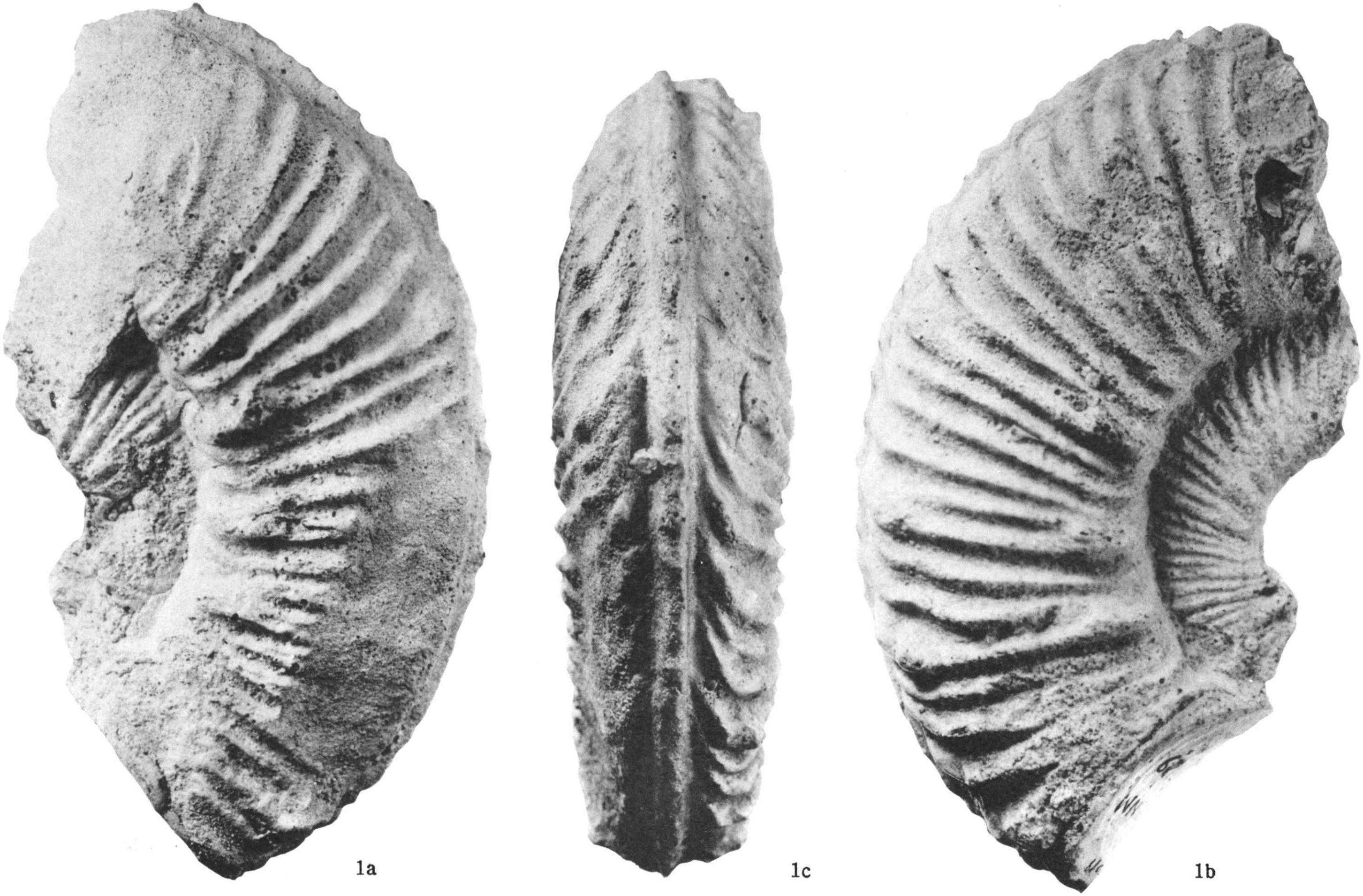


T. MATSUMOTO: Collignoniceratidae

Plate 16

Explanation of Plate 16

Fig. 1. *Prionocyclus wyomingensis* MEEK ....Page 18
GK.H9019c, a plaster cast of the lectotype, USNM.7729, from the valley of the Medicine Bow river, Frontier Formation, southeast Wyoming. Two lateral (a, b) and ventral (c) views, $\times 1$. Note the ventrolateral spines on the inner whorl.



1a 1c 1b

T. MATSUMOTO: Collignoniceratidae

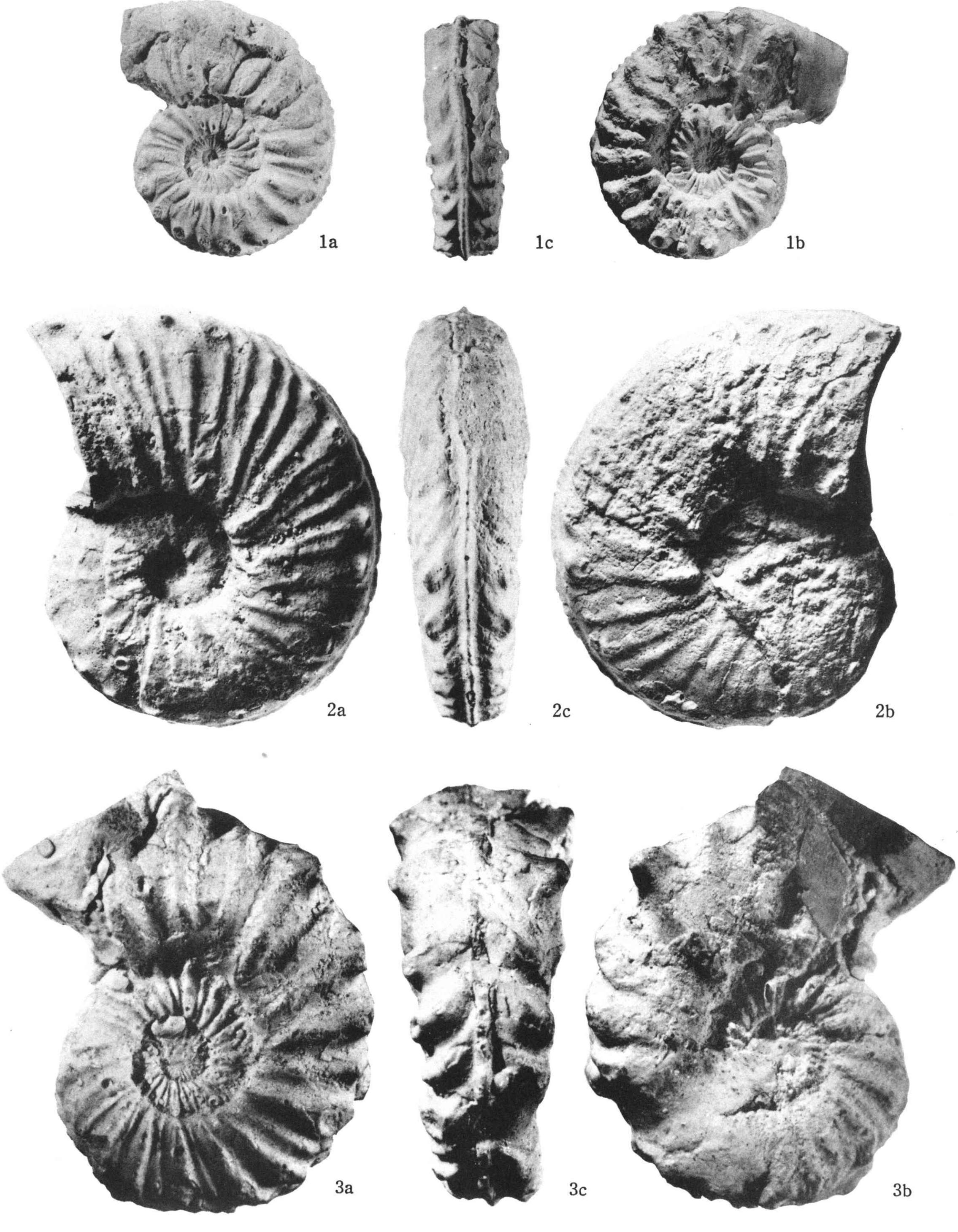
Plate 17

Explanation of Plate 17

Fig. 1. *Prionocyclus reesidei* SIDWELL..Page 21
GK.H9281, a plaster cast of holotype, kindly furnished from the University of Iowa through Professor W.M. FURNISH. Two lateral (a, b) and ventral (c) views ×1.

Fig. 2. *Prionocyclus wyomingensis* MEEK ....Page 18
GK.H9019 b, a plaster cast of a syntype (one of USNM. 6729), kindly supplied from USNM. through Dr. W.A. COBBAN. Two lateral (a, b) and ventral (c) views, ×1.

Fig. 3. *Prionocyclus hyatti* (STANTON) ....Page 19
GK.H9162, a plaster cast of the lectotype, USNM.22941 (A), kindly supplied from USNM. through Dr. W.A. COBBAN. Two lateral (a, b) and ventral (c) views, ×2.

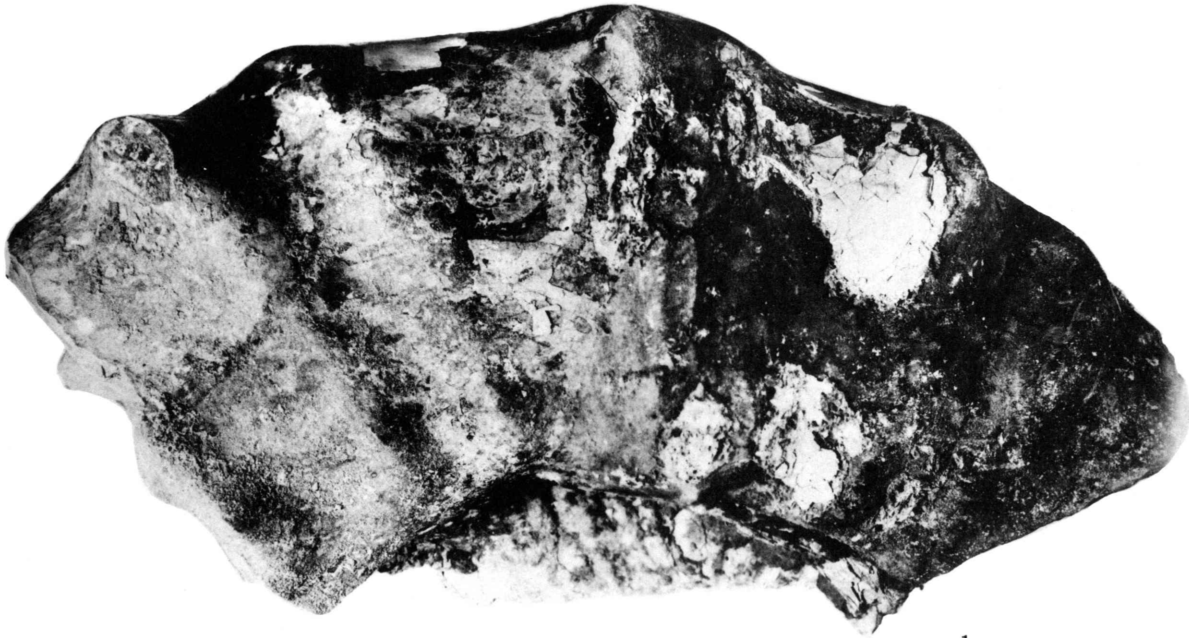


T. MATSUMOTO: Collignoniceratidae

Plate 18

Explanation of Plate 18

Fig. 1. *Prionocyclus wyomingensis* MEEK ....Page 18
GK.H7880, from loc. TM. 48, 7.5 miles NNW of Belle Fouche, SW 1/4, sec. 3, T. 9 N., R. 2 E., Butte County, South Dakota (Coll. T. MATSUMOTO under the guidance of Dr. W.A. COBBAN). Two lateral (a, b) and ventral (c) views, × 1/2. Example of a horned outer whorl.



1a

1b

1c

T. MATSUMOTO: Collignoniceratidae