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Cretaceous Cephalopods from the Sanchu Area, Japan

By

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Abstract—We describe seven ammonite species from the Cretaceous Ishido Formation of the Sanchu area in the Kwanto Mountains, including a new species and one nautiloid: *Simbirskites* (*Milanowskia*) sp., *Barremites* (*B.*) *difficilis* (D'ORBIGNY), and *Pulchellia ishidoensis* YABE et SHIMIZU from the lower part of the formation, *Phylloceras* sp., *Shasticrioceras* aff. *S. patricki* MURPHY, *Barremites* (*B.*) aff. *B. strettostoma* (UHLIG), *Pseudohaploceras japonicum* OBATA et MATSUKAWA sp. nov., and *Heminautilus* cf. *H. lallierianus* (D'ORBIGNY) from the upper part of the formation. Thus the lower part of the Ishido Formation is probably assignable to the Upper Hauterivian to the Lower Barremian, and the upper part of the formation to the upper Lower Barremian. Another ammonite species, *Anagaudryceras* cf. *A. sacya* (FORBES) from the upper member of the Sanyama Formation is described. The species is rather long-ranged, suggesting the Albian to the Cenomanian. These cephalopod species provide a basis for the detailed scheme of the Lower Cretaceous biostratigraphic zonation in Japan.

Introduction

The Lower Cretaceous deposits in Japan are distributed in some isolated areas of Honshu, Shikoku, Kyushu and Hokkaido. Although the sequence in each area does not cover the whole stages of the Early Cretaceous and the occurrence of fossils are rather poor, some appropriate schemes of biostratigraphic zonation of the Japanese Lower Cretaceous have been discussed (e.g. OBATA and MATSUMOTO 1977; MATSUMOTO *et al.*, 1982). The Cretaceous of the Sanchu area in the Kwanto Mountains is one of the prosperous strata to make up for a deficiency of the Lower Cretaceous biostratigraphy in Japan.

Many stratigraphical and paleontological works have hitherto been done: i.e., stratigraphy: YABE *et al.* (1926), IJIRI (1938), KOBAYASHI *et al.* (1943), IWAI and SUGIYAMA (1947), YABE (1955), FUJIMOTO *et al.* (1957), SHIRAKURA (1958), TAKEI (1963, 64), OKUBO and HORIGUCHI (1969), INOUE (1974), SAKA (1974), ARAI and NAGANUMA (1974), TAKEI *et al.* (1977), MATSUKAWA (1977), SAKA and KOIZUMI (1977) and MATSUKAWA (1979); mollusca: YABE *et al.* (1926), YABE and SUGIYAMA (1930),

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EGUCHI (1951), TANAKA and SHIBATA (1961), TANAKA (1965), HAYAMI (1965, 66), HAYAMI and ICHIKAWA (1965), HAYAMI and NAKAI (1965), OBATA *et al.* (1976) and MATSUKAWA (1979); plants; YOKOYAMA (1894), OHISHI (1940) and KIMURA and MATSUKAWA (1979). In spite of numerous works as mentioned above, the litho- and bio-stratigraphy of the Sanchu Cretaceous have been made rather independently. MATSUKAWA (1983), however, has established the lithostratigraphy and molluscan biostratigraphy on the basis of a geological survey over the area of the Cretaceous formations and made use of 24 species of cephalopods to discuss the inter-regional correlation. The present paper describes 8 species of ammonites among them including a new species, and one nautiloid, which are important for the inter-regional correlation.

We wish to record here a debt of gratitude to the following persons for various ways; Professors Kametoshi KANMERA (Kyushu University), Tamio KOTAKA (Tohoku University), Yukiyasu SAKA (Waseda University) and Kenji KURIHARA (St. Paul's University), Dr. Ienori FUJIYAMA (National Science Museum), and Messors. Kazuhiko UEMURA (National Science Museum), Masao FUTAKAMI (Tadao Senior High School), Shigeo MIYAZAKI and Esaburo SHIMIZU (Maebashi Daini Senior High School), Takashi TAKAHASHI (Nakazato-village, Gunma Prefecture), Shigeto USUDA (Nozawa Minami Senior High School), and Kiyohiko OGAI (Misato City, Saitama Prefecture). This study was financially suported in part by the Grant-in-Aid for Scientific Research (TAKAYANAGI, No. 334043 in 1978–1980; OBATA, No. 56340041 in 1981–1982; MATSUKAWA, No. 56740335 in 1981) of the Ministry of Education, Science and Culture in Japan.

Geological Notes

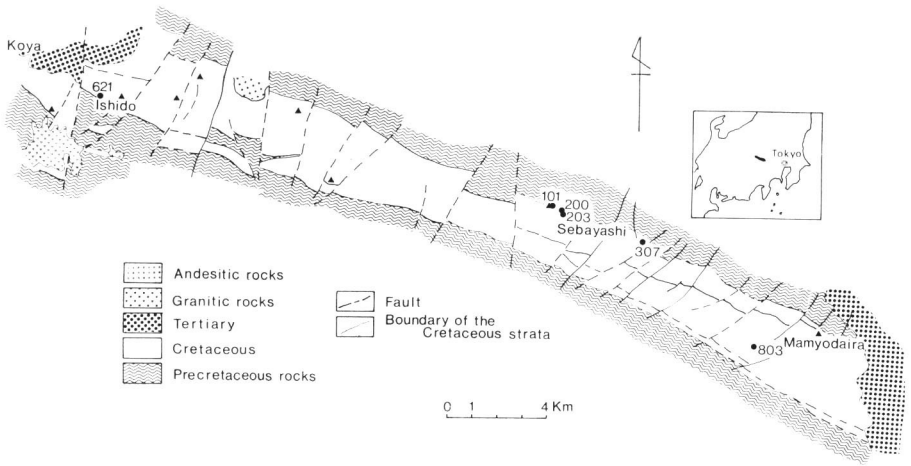
Cretaceous formations unconformably rest on the Pre-Cretaceous rocks (Carboniferous-Jurassic), and are divided as follows in descending order (MATSUKAWA, 1983).

Sanyama Formation ..... Upper Aptian to Lower Cenomanian
Sebayashi Formation ..... Lower Barremian to Aptian
Ishido Formation ..... Upper Hauterivian to Barremian
Shiroi Formation ..... Hauterivian
——Unconformity——
Pre-Cretaceous rocks ..... Lower Carboniferous to Jurassic

The localities of the described fossils from these Cretaceous formations are shown in the geological map (Text-fig. 1), and in the individual columnar sections (Text-fig. 2).

Pre-Cretaceous rocks

This is mainly chert, sandstone, slate, pyroclastic rocks and limestone. They have been variously mapped and named such as the Mamba Formation (FUJIMOTO,



Text-fig. 1. Geological map indicating fossil cephalopod localities of the described species (circles) in this paper and the others (triangles).

1936), the Kamiyoshida Formation (FUJIMOTO, 1936), the Hebiki Formation (OKUBO and HORIGUCHI, 1969), the Ryokami Formation (FUJIMOTO *et al.*, 1957) and the Otchizawa Formation (OKUBO and HORIGUCHI, 1969). The stratigraphic relationships of these formations, however, remain uncertain. Recent biostratigraphic studies on some micro-fossils (e.g. conodonts and radiolarians) indicate that the age of these Pre-Cretaceous rocks are period from Early Carboniferous to Jurassic (e.g. IGO, 1980 and SASHIDA *et al.*, 1982).

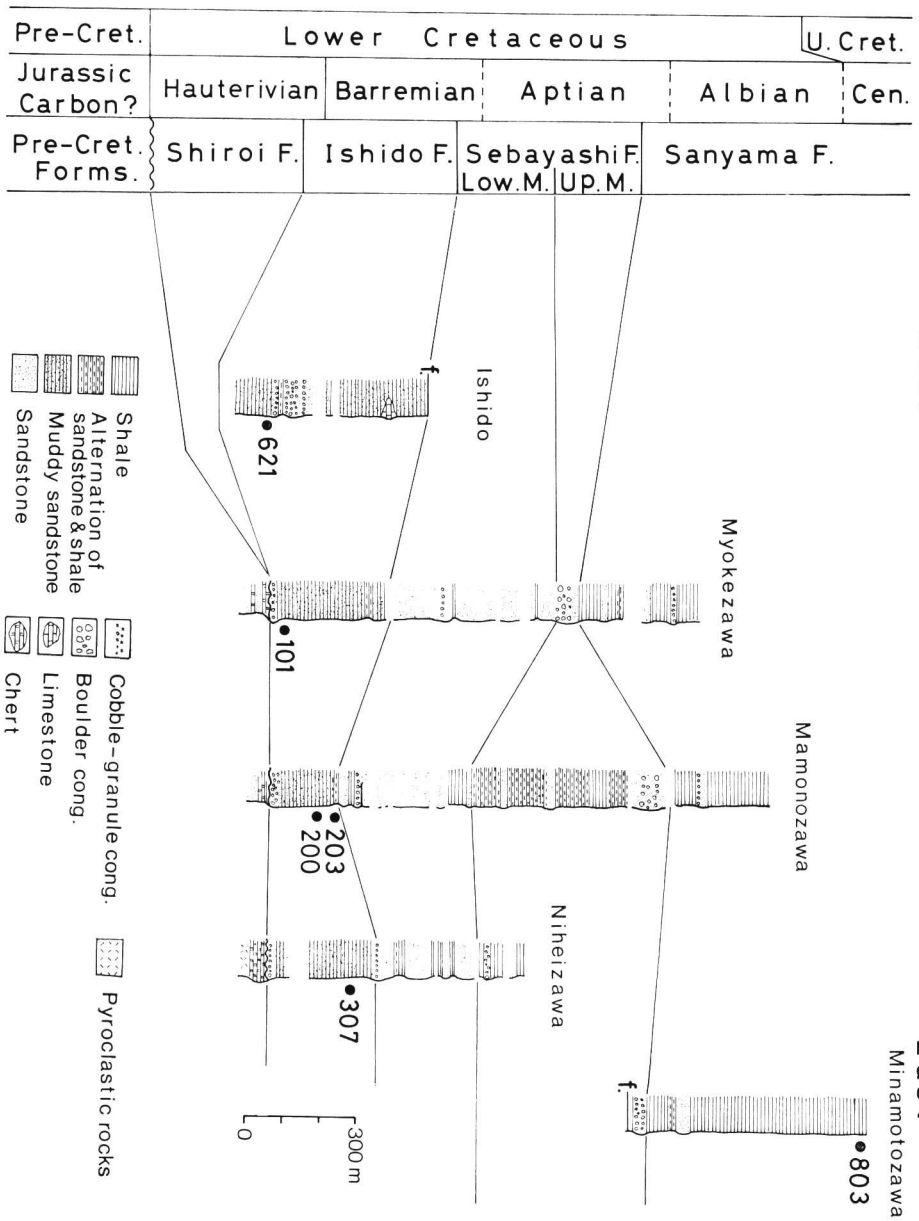
Shiroi Formation

This formation is exposed along the southern margin of the Cretaceous terrane, and is widespread towards the west.

It is considered to unconformably lie on the Pre-Cretaceous rocks by the reason that the basal conglomerate is directly bordered by the Pre-Cretaceous rocks and some outliers of it occur in the latter area. The Shiroi Formation is composed mainly of conglomerate with intercalations of sandstone and shale. It shows several normal or upward-fining sedimentary cycles. The sandstone and shale in the middle and upper parts of this formation yields abundant non-marine fossils; bivalves such as *Costocyrena otsukai*, *Protocyprina naumanni* and the others, and gastropods, together with plant debris. The Shiroi Formation can be correlated approximately with the Hauterivian from the evidence of the overlying ammonoids-bearing Ishido Formation (Late Hauterivian to Barremian).

Ishido Formation

This formation is narrowly distributed with a WNW–ESE trend along the southern and northern flanks of the Sanchu Terrane, except for the northern flank of the central area. It gradually thickens from east to west. The Ishido Formation conformably overlies muddy sandstone of the upper part of the Shiroi Formation with a coarse-



Text-fig. 2. Individual columnar sections with the indication of the horizons which yielded the cephalopod species (circles).

grained sandstone in the southern flank of the western and central areas, but it unconformably oversteps the Pre-Cretaceous rocks with a basal conglomerate in other area. The basal conglomerate is about 30 meters thick and is composed mainly of subangu-

lar pebbles of chert. The pebble conglomerate grades laterally into granule conglomerate or coarse-grained sandstone in the southern flank of the western and central areas. Muddy sandstone, overlying the basal conglomerate, constitutes the main part of the Ishido Formation. From the lower to the upper part of the formation yields abundant marine invertebrate fossils; bivalves such as *Nuclopsis* (*Paleonucula*) *ishidoensis*, *Nanonavis* (*N.*) *yokoyamai*, *Neithea* (*N.*) *atava*, *Entolium sanchuensis*, *Pterotrigonia* (*P.*) *hokkaidoana*, *Astarte* (*A.*) *subsenecta* and the others, gastropods, echinoids and coelenterata. Cephalopods were found from three horizons, that is, one from the lower part, the other two from the upper part of the formation. We will describe 8 species of them in the succeeding chapter.

The geological ages given by the ammonoids indicate that the lower part of the formation is assigned to the late Late Hauterivian to Early Barremian suggested by *Simbirskites* (*Milanowskia*) sp., *Pulchellia ishidoensis* and *Barremites* (*B.*) *difficilis*. The upper part of the formation is assigned to the Late Barremian based on the presence of *Barremites* (*B.*) aff. *B. strettostoma* and *Heteroceras* (*H.*) aff. *H. astieri*.

Sebayashi Formation

This formation is made up of sandstone and shale in the lower, shale and alternating beds of sandstone and shale in the upper, and conglomerate and/or sandstone in the uppermost part. The Sebayashi Formation is divided into two members, the lower and the upper.

a) Lower Member

The member is exposed over the eastern, central and western areas, and conformably overlies the Ishido Formation. It is generally composed of dark grey to light grey fine- to medium-grained sandstone with some interbeds of thin bedded alternation of sandstone and shale, and shale. The shale interbeds contain a large number of fresh- and brackish-water bivalves such as *Costocyrena radiatostriata*, *Protocyprina* aff. *P. naumanni*, *Nippononaia ryosekiana* and the others, gastropods, and terrestrial plant remains.

b) Upper Member

The member conformably overlies the Lower Member. It is composed of shale or rhythmically alternating beds of sandstone and shale, with some thick interbeds of shale and sandstone in the main part, and of coarse-grained sandstone or conglomerate in the uppermost part. Fossils are rare in the member.

The formation is difficult of the inter-regional correlation, because the occurrence of cephalopods are poor. Therefore the age of the Sebayashi Formation is given by the underlying ammonoids-bearing Ishido Formation. As the uppermost part of the Ishido Formation is assigned to the upper Barremian, the overlying Sebayashi Formation may be referred to the upper Barremian to the Aptian.

Sanyama Formation

The formation widely distributed in the Sanchu Cretaceous Terrane, and conformably overlies the Sebayashi Formation with a rapid change of lithology. It is composed mostly of black sandy shale, in which many sorts of sedimentary structures

such as graded bedding, parallel and cross lamination, and sole marks are visible. The formation shows a monotonous lithology throughout the thickness over the whole area. Foraminiferal fossils have been known from the lower to the upper part of the formation (personal communication from Dr. K. Kurihara). Although megafossils are rare in the formation, the upper part occasionally contains ammonoids, one of which will be described in the succeeding chapter.

The geological age of the Sanyama Formation has been interpreted to the Gyliakian in the Japanese standard based on *Inoceramus* cf. *I. hobetsensis* by Takei (1964), the Turonian based on *Collignoniceras* (?) cf. *C. woollgari* by Takei *et al.* (1977), and the Upper Miyakoan to the Lower Gyliakian in Japanese standard (nearly corresponds to the Middle Albian to the Upper Cenomanian in the international scale) based on *Anagaudryceras* cf. *A. sacya* by Matsukawa (1983).

Biostratigraphy and Correlation

Cephalopods from the Ishido Formation were found from three horizons, that is, one from the lower part, the other two from the upper part of the formation. The characteristic species are as follows: *Barremites* (*B.*) *difficilis*, *Pulchellia ishidoensis* and *Simbirskites* (*Milanowskia*) sp. from the lower horizon, *Shasticrioceras* aff. *S. patricki* from the middle, and *Phylloceras* sp., *Barremites* (*B.*) aff. *B. strettostoma*, *Pseudohaploceras japonicum*, *Heteroceras* (*H.*) aff. *H. astieri* and *Heminautilus* cf. *H. lallierians* from the upper. As noted in the paleontological description in the next chapter of this paper, these cephalopods are identical with or similar to the Upper Hauterivian to the Barremian species. The correlation of the Ishido Formation based on these cephalopods with the Lower Cretaceous of Tethys province including stratotype area, the Boreal and the Circum Pacific province is possible.

In the Tethys province *Barremites* (*B.*) *difficilis* appears to be an index of the Barremian. Besides, the Lower Barremian is represented by *Pulchellia compressissima*, and the Upper Barremian by *Barremites* (*B.*) *strettostoma* and *Heteroceras* (*H.*) *astieri* (Busnard, 1965). In California of the Circum Pacific province, the successive occurrence of *Shasticrioceras patricki*, *S. roddai* and *S. poniente* is confirmed in the lower part of the Ono Formation. The *S. patricki* range-zone yields *Pulchellia* cf. *P. compressissima*. As *Pulchellia* cf. *P. compressissima* and *Heteroceras jeletzkyi* are similar respectively to *Pulchellia compressissima* and *Heteroceras* (*H.*) *astieri* obtained from the stratotype of the Barremian in France, the lower part of the Ono Formation is correlated with the Barremian (Murphy, 1975). From these lines of evidence, the faunal composition is compared with those from the Tethyan and the Circum Pacific Realm.

Furthermore, *Simbirskites* (*Milanowskia*) sp. from the lower part of the Ishido Formation is similar to *Simbirskites* (*M.*) *speetonensis* from the lower part of the Speeton Clay in England (Rawson, 1971). Genus *Simibirskites* is one of the characteristic genera in the Hauterivian of the Boreal province (Rawson, 1971; Kemper, 1972). In

Caucasus, the Lower Barremian with a Tethyan fauna (e.g. *Barremites* (*B.*) *difficilis*) conformably overlies the Upper Hauterivian with a Boreal fauna (e.g. species of *Simbirskites*). Accordingly, the *Simbirskites* (*Milanowskia*) *speetonensis* zone in Caucasus is correlated with the Upper Hauterivian (DRUSHITCHITS & GORBATSCHIK 1979; RAWSON, 1971). On the other hand, the peculiar faunal composition typified by the coexistence of *Simbirskites* (*Milanowskia*) sp. with *Pulchellia ishidoensis* and *Barremites* (*B.*) *difficilis* in the lower part of the Ishido Formation has not yet been reported from foreign countries, and provides an interesting mixture of different faunal elements in the Japanese province. This may be a key for the inter-regional correlation between different provinces. Therefore, the lower part of the Ishido Formation is correlative with the upper Upper Hauterivian to the Lower Barremian. The cephalopod assemblage from the middle horizon in the upper part of the Ishido Formation is composed of Californian faunal element, while that of the upper horizon comprises the Tethyan ones. Thus the cephalopod assemblages in the Ishido Formation include elements of three different provinces in one and the same sequence.

The Sanyama Formation is rare in mega-fossils. *Anagaudryceras* has been known from Europe, North Africa, Madagascar, South India, Japan, etc. (WRIGHT, 1957). *Anagaudryceras sacya* is long-ranging species occurring approximately from the Middle Albian to the Upper Cenomanian in Japan (MATSUMOTO, 1963). Further fossil evidence is required to determine the upper limit of the Sanyama Formation. In this paper, we provisionally assign the Sanyama Formation to the upper Aptian to the lower Cenomanian.

Thus, cephalopods occured commonly from the Ishido Formation and rarely from the Sanyama Formation. Among them some ammonoids indicate that the Ishido is correlated with the Upper Hauterivian to the Upper Barremian, and that the Sanyama with the Upper Aptian to the Lower Cenomanian. Hence, the Sebayashi which lies between these two formations is probably referable to the Uppermost Barremian to the Aptian. The Shiroi Formation which underlies the Ishido is probably assignable to the Hauterivian.

Repository

Most of the material used in this study are the collections of the National Science Museum, Tokyo. They are prefixed as NSM-PM.

The collections preserved in several other institutions were also studied and described. These institutions are as in the following:

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

Department of Geology, Faculty of General Education, Shinshu University (SGE), Matsumoto

Gunma Prefectural Museum (GM), Takasaki

Systematic Description

(by Ikuwo OBATA and Masaki MATSUKAWA)

Order Ammonoidea ZITTEL, 1884
Suborder Phylloceratina ARKELL, 1950
Superfamily Phylloceratacea ZITTEL, 1884
Family Phylloceratidae ZITTEL, 1884
Subfamily Phylloceratinae ZITTEL, 1884
Genus ***Phylloceras*** SUESS, 1865

Types species: *Ammonites heterophyllus* J. SOWERBY, 1820, from Toarcian of England.

Phylloceras sp.

Pl. 4, Fig. 1a, b.

Material: OG-1, a specimen from loc. SA-200R, collected by K. OGAI.

Description: The shell is large, discoidal and involute. The whorl is compressed, slightly inflated at the middle of whorl height and the venter is narrow but rounded. The flanks are very gently convex. Thus the whorl is slightly convergent. The test is thin. Numerous subcostae are very densely arranged, show rectiradiate but sinuous curvature on the flank, and are very gently arched on the venter. They are weak in the umbilical side, but become gradually conspicuous in the ventral side of the flank. Some of the subcostae are stronger than the others. No sutures have been observed.

Measurements (in mm):

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
OG-1	229.5(1)	20.0(0.09)	125.0	—	
	ca 166.1(1)	— —	84.7	43.2	0.51

Remarks: The illustrated specimens of *Phylloceras onoense* STANTON (ANDERSON, 1938, p. 142, pl. 11, figs. 1, 2; MATSUMOTO, 1959a, p. 4, pl. 2, fig. 1), the type species of the subgenus *Hypophylloceras*, from the probable Aptian of California are similar to the present specimen in the density of ribs, but their ribs are less sinuous in curveture than those of the latter, although the exact comparison is impossible because of the difference of the growth stage. *Hypophylloceras yeharai* (NAKAI and MATSUMOTO, 1968, p. 4–7, pl. 1, figs. 1–3, pl. 3, figs. 1, 2) from the upper Albian of Fujikawa Formation, Tokushima Prefecture has stouter ribs, less distinctly sinuous curvature of ribs and lirae and a smaller shell. The present specimen is somewhat similar to that of *Phylloceras* (*P.*) *serum* (OPPEL) (KENNEDY and KLINGER, 1977, p. 352–354, pls. 1–3) from the Barremian of Zululand in the sinuousity of ribs, but is higher than the latter, although the exact comparison at the same growth stage is impossible. Anyhow, we temporally assign the specimen from the Ishido Formation to *Phylloceras* sp. by reason of insufficient preservation.

Occurrence: Loc. SA-200R, in Nakazato Village, Tano County, Gunma Prefecture. The stratigraphic horizon is probably assigned to the upper part of the Barremian.

Suborder Lytoceratina HYATT, 1889
Superfamily Lytocerataceae NEUMAYR, 1875
Family Tetragonitidae HYATT, 1900
Subfamily Gaudryceratinae SPATH, 1927
Genus ***Anagaudryceras*** SHIMIZU, 1934

Type species: *Ammonites sacya* FORBES 1846, by the original designation of SHIMIZU (1934).

Remarks: Nomenclatorial problems of *Anagaudryceras* have been discussed by many previous authors (WRIGHT and MATSUMOTO, 1954, p. 111–113; MATSUMOTO, 1959a, p. 138, 1959b, p. 73, WIEDMANN, 1962, p. 156–158; HOWARTH, 1965, p. 357; KENNEDY and KLINGER, 1979, p. 144). We follow MATSUMOTO's opinion (1959a, p. 73) with respect to the interpretation and diagnosis of *Anagaudryceras* and *Ammonite sacya* FORBES.

Anagaudryceras cf. ***A. sacya*** (FORBES)

Pl. 3, Fig. 2.

Compare:
1846 *Ammonites sacya* FORBES, *Trans. Geol. Soc. London.*, vol. 7, p. 113, pl. 14, fig. 10.
1959 *Anagaudryceras sacya* (FORBES), MATSUMOTO, *Mem. Fac. Sci. Kyushu Univ.*, ser. D, 8, (3), p. 72–74, pl. 22, figs. 4, 5a-c.

Material: NSM-PM 9496, an imperfect internal mould of the left side of a shell.

Descriptive remarks: This specimen is secondary compressed and the original whorl breadth is difficult to estimate. The breadth of umbilicus in proportion to diameter is moderate. Measurements (in mm) of the unrestored specimen are as follows; Diameter=76.6, Whorl-height=35.0, Umbilicus=27.6 (0.36).

Presumably, the whorl was originally higher than broad with a rounded venter; the sharpened venter of the shell is probably due to the secondary compression. The specimen has, in its outer whorl, fairly low, broad radial ribs which start at the umbilical margin. The ribs are mostly rather flat at the top, but occasionally somewhat rounded in the umbilical side. They are separated by narrow furrows which periodically appear on the flank of the body chamber (26.6 mm to 34.8 mm in height): the breadth of the ribs is about 10 mm in the later part of body chamber, and about 5 mm in the early part. The ribs surface is smooth. The complicated suture line of *Gaudryceras* type is partly preserved, but no details have been observed.

Occurrence: This specimen was obtained by T. WATANABE at loc. 803, west of Mamyodaira, Ogano-machi, Chichibu-gun, Saitama Prefecture. It came from a sandy black shale of the upper member of the Sanyama Formation.

Suborder Ancyloceratina WIEDMANN, 1960
Superfamily Ancyloceratacеae GILL, 1871
Family Ancyloceratidae GILL, 1871
Subfamily Crioceratitinae GILL, 1871
Genus ***Shasticrioceras*** ANDERSON, 1938

Type species: *Shasticrioceras poniente* ANDERSON, 1938, from the Barremian deposits of California, subsequent designation by WRIGHT, 1957, p. L 208.

Remarks: Since ANDERSON established Genus *Shasticrioceras*, the following nine species and one questionable species have been described by succeeding authors;

Shasticrioceras poniente ANDERSON		1938	California, U.S.A.
S.	*whitneyi* A.	1938	ditto
S.	*hesperum* A.	1938	ditto
S.	*inflatum* A.	1938	ditto
S.	*nipponicum* MATSUMOTO	1947	Arida, Japan
S.	*anglicum* DOYLE	1963	Yorkshire, England
S.	*bifurcatum* DIMITOROVA	1967	Burgaria
S.	*patricki* MURPHY	1975	California, U.S.A.
S.	*roddai* M.	1975	ditto
S.	*wintunium* (ANDERSON)	1975	ditto

ANDERSON (1938, p. 204–205, pl. 56, figs. 1–4; pl. 57, figs. 1–3; pl. 58, figs. 1, 4) described, on the occasion of establishing the genus, four species which yielded from the Barremian deposits of the Mitchell Creek area, the lower part of the Horsetown Group in Shasta County, California. MATSUMOTO (1947) described a new species or a new variety of *S. hesperum*, *S. nipponicum*, based on a juvenile shell (p. 17, text-fig. 2, pl. 1, fig. 3), and photographed another specimen as *S.* cf. *S. poniente* (pl. 1, fig. 4) from the upper part of the Arida Formation, Yuasa, Wakayama Prefecture, Japan. MURPHY (1975, pl. 41–48, pl. 3, fig. 4; pl. 7, figs. 1, 2; pl. 9, figs. 1, 3–7; pl. 10, figs. 1–6; pl. 11, figs. 5, 7; pl. 12, figs. 1–5; pl. 13, fig. 4) described *S. poniente*, *S. whitneyi*, *S. roddai*, *S. patricki* and *S.* (?) *wintunium*. He discussed *S. nipponicum* (MATSUMOTO, 1947, pl. 19; figs. 3, 4) in connection with *S. poniente* and suggested that *S. nipponicum* may be a young representative of *S. poniente* (ANDERSON, 1938, p. 41–43, pl. 57, fig. 1) by reason of the wide scope of variability in early stages of *S. poniente* (MURPHY, 1975, p. 40). We believe, however, that *S. nipponicum* is distinguished from *S. poniente*, because the former species has a more tightly involute and less numerous whorls than the latter at the same stage of growth, e.g. 54 mm in diameter (OBATA and OGAWA, 1976, p. 105).

Shasticrioceras aff. ***S. patricki*** MURPHY

Pl. 5, Fig. 2a, b; Pl. 6, Fig. 2.

Compare:

1975 *Shasticrioceras patricki* MURPHY, *Univ. Calif. Pub. Geol. Sci.*, vol. 113, p. 46–47, text-fig. 26; pl. 7, figs. 1, 2; pl. 10, figs. 3–5; pl. 13, fig. 4.

Material: NSM-PM 9376, a plaster cast from loc. SA-200, collected by K. OGAI and M. MATSUKAWA. GM-1, a specimen probably from loc. SA-200, collected by T. TAKAHASHI; A plaster cast of GM-1 is preserved in the National Science Museum, with prefix NSM-PM 9377.

Description: The shell is large, but the whorl is slightly uncoiled. The whorl section is subquadrangle with moderately inflated flanks at the known stages, but the umbilical half side is less compressed than the ventral side. There are numerous, almost radial, but very slightly sinuous ribs, which start at the umbilical margin and become weaker on the venter. They are rather fine in young stages (i.e. 89 mm and below in diameter of GM-1), and gradually increase the coarseness, becoming fairly coarse at 174 mm in diameter and very coarse at above 260 mm in diameter of the preserved specimen (GM-1). The venter is rather flattened (NSM-PM 9376). At the peripheral margin of the venter, there are distinct clavate tubercles on ribs (i.e. 53 per whorl at 159 mm in diameter of NSM-PM 9376). The top of clavi is rather pointed.

Measurements (in mm):

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
NSM-PM 9376	159(1)	65.5?(0.41?)	62.5(0.39)	33.0?(0.21?)	0.53
GM-1	241(1)	98.0 (0.41)	73.0(0.30)	— —	—

Remarks: The present species is similar to in many respects *Shasticrioceras patricki* MURPHY from the upper part of the Lower Barremian of California. It seems, however, to have more involute, higher whorls and a narrower section at the umbilical half of flanks. The present material is insufficient in preservation, so we temporarily describe it under *S.* aff. *S. patricki* MURPHY. *Shasticrioceras nipponicum* from the Lower Barremian of the Arida Formation (MATSUMOTO, 1947, p. 19, fig. 3; OBATA and OGAWA, 1976, p. 104, pl. 1, figs. 1, 3) is also similar to the present species. However, it is different in having a narrow venter, more remarkable clavate tubercles at the soulder, and coarser and more frequently branched ribs at the umbilical margin, although the detailed comparison cannot be made because of the difference of growth stages of the materials. *Shasticrioceras* sp. illustrated by OBATA and OGAWA (1976, p. 107, pl. 1, fig. 5) from the Lower Barremian of the Arida Formation is different from the present species in its rather irregular type of ribbing; the main ribs are stronger and the subordinate ones finer, and they are more widely interspaced. Also the presence of tubercles on the lateral part of main ribs is a characteristic of *Shasticrioceras* sp.

Occurrence: Loc. SA-200, in Nakazato Village, Tano county, Gunma Prefecture. The stratigraphic position of this bed is probably assigned to the upper part of the Lower Barremian.

Suborder Ammonitina HYATT, 1900
Superfamily Perisphinctaceae STEINMANN, 1890
Family Olcostephanidae HAUG, 1910
Genus ***Simbirskites*** PABLOW, 1892

Type species: *Ammonites decheni* ROEMER 1841, by original designation.

Subgenus ***Milanowskia*** CHERNOVA, 1952

Type species: *Ammonites speetonensis* YOUNG et BIRD 1828, by original designation.

Simbirskites (Milanowskia) sp.

Pl. 1, Fig. 2a, b.

1926 *Simbirskites kochibei* YABE et SHIMIZU in YABE *et al.*, *Sci. Rep. Tohoku Imp. Univ.*, ser. 2, vol. 4, p. 37, pl. 4, figs. 9, 10.

Material: A single specimen IGPS 22847, the holotype, described by YABE and SHIMIZU (1926).

Description: The shell is small, compressed, and involute, having an arched venter. The umbilicus is of moderate width (32%) in proportion to diameter, and is surrounded with a steep wall which gradually passes upward into flanks. The shell surface is ornamented with numerous radial ribs. The ribs are almost rectiradiate: the primary ribs mostly branch at umbilical bullae and again at the mid-flank, but some are single. Secondary ribs are intercalated not only in the early stage but also in the late stage. The ribs slightly curve forwardly on the rounded venter.

Measurements (in mm):

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
IGPS-22847	16.0(1)	5.2(0.32)	6.4	4.8	0.75

Remarks: This species is somewhat similar to *Simbirskites* (*Milanowskia*) *speetonensis* (YOUNG et BIRD) (RAWSON, 1971, p. 50–52, pl. 2, figs. 7, 9–11; pl. 11, fig. 4) in having a slender shell-form, numerous and delicate ribs, and weak umbilical bullae in immature stages. Furthermore, *Simbirskites* (*Milanowskia*) *speetonensis* described by RAWSON from the Speeton Clay shows a remarkable interspecific variation in the whorl proportions and the mode of ribbing. Accordingly, the possibility that *Simbirskites kochibei* of YABE et SHIMIZU (1926) is synonymous with *Simbirskites* (*Milanowskia*) *speetonensis*, 1828 can not be denied, but we tentatively treat this species under *Simbirskites* (*Milanowskia*) sp. because of insufficient material in our disposal. In any way it is necessary to obtain more well-preserved specimens, especially of the adult stage, for identification of this species.

Occurrence: Loc. SA-621, a muddy sandstone bed in the lower part of the Ishido Formation, about 4 km east of Koya, Saku-machi, Nagano Prefecture. This bed is probably assigned to the Upper Hauterivian to the Lower Barremian.

Superfamily Desmoceratacea ZITTEL, 1895
Family Eodesmoceratidae WRIGHT, 1955
Subfamily Eodesmoceratinae WRIGHT, 1955
Genus ***Barremites*** KILIAN, 1913

Type species: *Ammonites difficilis* D'ORBIGNY 1841, by original designation.

Subgenus ***Barremites*** WRIGHT, 1953

Type species: *Ammonites difficilis* D'ORBIGNY 1841, by original designation.

Barremites (Barremites) aff. ***B. strettostoma*** (UHLIG)

Pl. 1, Figs. 1a, b, 3.

1976 *Barremites* (*B.*) aff. *B. strettostoma*, OBATA *et al.*, *Bull. Natn. Sci. Mus.*, ser. C, Vol. 2, No. 2, p. 128–129, pl. 1, fig. 1, pl. 2, fig. 4.

Remarks: *Barremites* (*Barremites*) aff. *B. strettostoma* from the Sanchu Cretaceous has been described by OBATA *et al.* (1976). Their species is evidently assigned to the subgenus *Barremites* in that the shell is very involute, compressed, high-whorled, with steep walls bounded by a sharp edge, and has sinuous to falcoid, faint riblets or lirae. YABE and SHIMIZU in YABE *et al.* (1926, p. 68) once described *Pseudosaynella otsukai*. Their specimen has been assinged to the genus because of the resemblance in outline and ornamentation to certain species of *Pseudosaynella*. Certainly, *Pseudosaynella otsukai* closely resembles the present species in having nearly flattened flanks, a compressed whorl, a gently arched and narrow venter, and a small umbilicus. Only the difference between the two species may be the existence of sinuous constrictions in *Pseudosaynella otsukai*. The fossil locality of YABE and SHIMIZU in YABE *et al.* (1926)'s specimen may correspond to either of our localities 306 and 307, and is situated near loc. 203. The stratigraphic positions of these localities are probably included in the upper part of the Ishido Formation. Furthermore, at locs. 203, 306 and 307 there occur *Barremites* (*Barremites*) aff. *B.* (*B.*) *strettostoma*, *Heteroceras* (*Heteroceras*) aff. *H.* (*H.*) *astieri*, etc. Accordingly, the strata at these localities are assigned to the Upper Barremian.

To sum up, the possibility that *Pseudosaynella otsukai* represents an adult stage of *B.* (*B.*) aff. *B.* (*B.*) *strettostoma*, can not be denied, although we hesitate to assign the present species to *Barremites* (*B.*) *otsukai* (YABE et SHIMIZU) before larger specimens of the present species become available.

Barremites (Barremites) difficilis (D'ORBIGNY)

Pl. 1, Figs. 5a, b, c, d, e, 6, 7.

1840 *Ammonites difficilis* D'ORBIGNY, *Lib. Vic. Mas.*, p. 135, pl. 41, figs. 1, 2.

1926 *Desmoceras* (?) *pseudodifficile* YABE et SHIMIZU in YABE *et al.*, *Sci. Rep. Tohoku Imp. Univ.*, ser. 2, p. 70 (38), pl. 15 (4), fig. 11.

Material: SGE-003, collected by TANAKA, and SGE-004 collected by K. ENDO. These specimens have been obtained from loc. SA-621.

Description: The two specimens are below 55 mm in diameter, in which the last whorl is almost unseptate. The shell has a fairly narrow umbilicus, and is moderately involute. The umbilicus is rather deep, surrounded by low but steep walls, which are nearly perpendicular to the flank and are sharply angular at the rim. The

whorl is high and much compressed. The breadth is maximum near at about one-third of the flank from the umbilical margin. Flanks are gently inflated and gradually convergent into a gently arched narrow venter. The outer whorls are ornamented with numerous, flexiradiate, faint lirae which are nearly obsolete in the inner half, distinct in the outer half and crossing with a projection on the venter in parallel to the constriction. Constrictions are frequently and slightly biconcave, but sometimes variable in intervals and distinctness, and strongly projected on the venter. The suture is observable, but details are uncertain because of imperfect preservation.

Measurements (in mm):

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
SGE-003	53.7(1)	13.0(0.24)	24.0	—	—
SGE-004	50.0(1)	8.1(0.16)	23.2	—	—
			16.0	6.5	0.40
D'ORBIGNY 1840, pl. 41, figs. 1, 2.	82.0(1)	13.2(0.16)	42.0	15.0	0.36
YABE *et* SHIMIZU, 1926, pl. 4, fig. 16.	37.0(1)	8.0(0.21)	17.0	—	—

Remarks: The present specimens and the holotype of *D.* (?) *pseudodifficile* closely resemble the holotype of *Ammonites difficilis* D'ORBIGNY (D'ORBIGNY, 1840, p. 135–136, pl. 41, figs. 1, 2) from the stratotype of the Barremian in that the breadth to height ratio is much compressed, the umbilicus is narrow or fairly narrow, the constrictions are strongly forwarded and flexuous, and in having more numerous, faint lirae and a broader whorl at a little below the mid-flanks.

Occurrence: Loc. SA-621, a muddy sandstone bed in the lower part of the Ishido Formation, Ishido, Saku-machi, Nagano Prefecture. The bed is probably assigned

Explanation of Plate 1

Fig. 1. *Barremites* (*B.*) aff. *B. strettostoma* (UHLIG). NSM-PM 7281 from loc. 203 (H. TSUDA coll). Ventral (a), lateral (b) and apical (c) views, ×1.1.

Fig. 2. *Simbirskites* (*Milanowskia*) sp. IGPS 22847 from loc. 621 (H. YABE, T. NAGAO and S. SHIMIZU coll.). Lateral (a) and ventral (b) views, ×1.8.

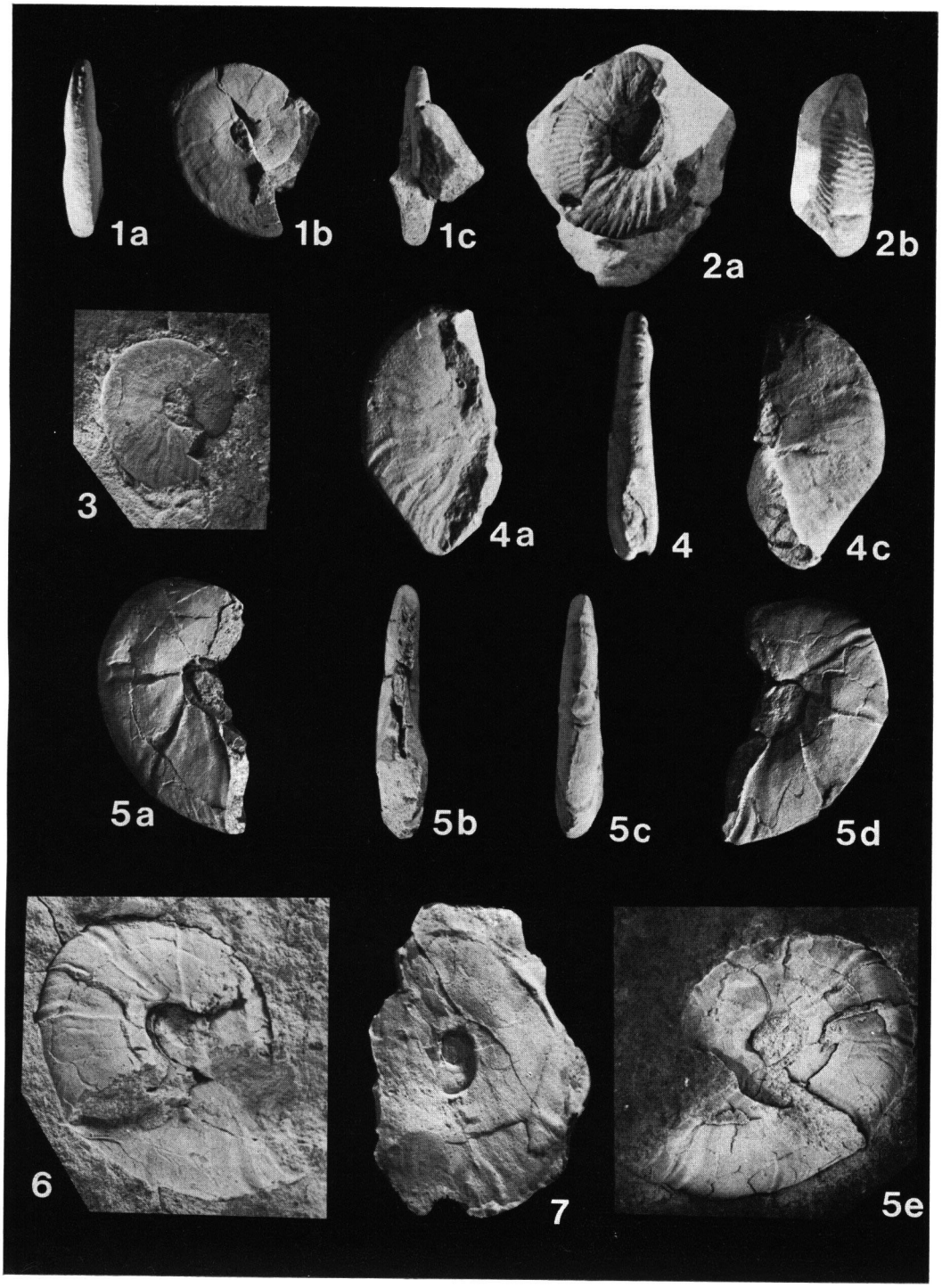
Fig. 3. *Barremites* (*B.*) aff. *B. strettostoma* (UHLIG). NSM-PM 7282 from loc. 203 (H. TSUDA coll.). Lateral view, ×1.1.

Fig. 4. *Barremites* (*B.*) *otsukai* (YABE et SHIMIZU). IGPS 22854 from loc. 621 (H. YABE, T. NAGAO and S. SHIMIZU coll.). Lateral (a, c) and ventral (b) views, ×1.1. Read 46 for 4.

Fig. 5. *Barremites* (*B.*) *difficilis* D'ORBIGNY. SGE-003 from loc. 621 (K. TANAKA coll.). Lateral (a, d, e), apical (b) and ventral (c) views, ×1.1 (Excluding e× 0.9).

Fig. 6. *Barremites* (*B.*) *difficilis* D'ORBIGNY. SGE-004 from loc. 621 (K. ENDO coll.). Lateral view, ×0.9.

Fig. 7. *Barremites* (*B.*) *difficilis* D'ORBIGNY. IGPS 6965 from loc. 621 (H. YABE, T. NAGAO and S. SHIMIZU coll.). Ventral view, ×1.1.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to the Upper Hauterivian to the Lower Barremian. In addition to this species, *Simbirskites* (*Milanowskia*) sp., *Pulchellia ishidoensis*, etc. occured from the same locality. Some molluscan shells such as *Pterotrigonia* (*P.*) *hokkaidoana*, *Nanonavis* (*N.*) *yokoyamai*, etc. were also found at the locality.

Family Pulchellidae HYATT, 1903
Genus ***Pulchellia*** UHLIG, 1883

Type species: *Ammonites galeatus* von BUCH 1839, by subsequent designation (GIGNOUX, 1921). See WRIGHT, 1957, L. 382.

Remarks: Diverse opinions have been presented concerning the distribution of subgenera *Pulchellia* and *Heinzia* and the adoption of the latter subgenus. BÜRGL (1956) recognized that *Pulchellia* (p. 55) from the Middle Barremian is characterized by a narrow umbilicus (below 10%) and *Heinzia* from the upper Middle Barremian in Colombia (p. 4) by a wide umbilicus (25%). BUSNARD (1965) presented a range chart (table 1) of the species of the two subgenera in the stratotype of the Barremian of Angles, and suggested that *Pulchellia* is an index of the Lower Barremian and *Heinzia* that of the Upper one. MURPHY (1975, p. 22) followed BÜRGL (1965) and BUSNARD (1965) in recognizing that subgenus *Heinzia* is useful for the Barremian biostratigraphy. WRIGHT (1957, p. L 328) noted the presence of the ventrolateral tubercles during early or middle stages, but regarded *Heinzia* as synonymous with *Pulchellia*.

The Japanese specimens, as described below, have two ventrolateral tubercles and a rather narrow umbilicus (10%–14%), and occur from the middle Aridan that is approximately referable to the uppermost Hauterivian to the lowest Barremian. Under such circumstances, the authors are inclined to follow WRIGHT's classification (1957, p. L382).

Pulchellia ishidoensis YABE et SHIMIZU

Pl. 2, Figs. 1a, b, c, d, 2, 3.

1926 *Pulchellia ishidoensis* YABE et SHIMIZU, *Sci. Rep. Tohoku Imp. Univ.*, vol. 9, no. 2, p. 74, pl. 15, figs. 22–24.

Explanation of Plate 2

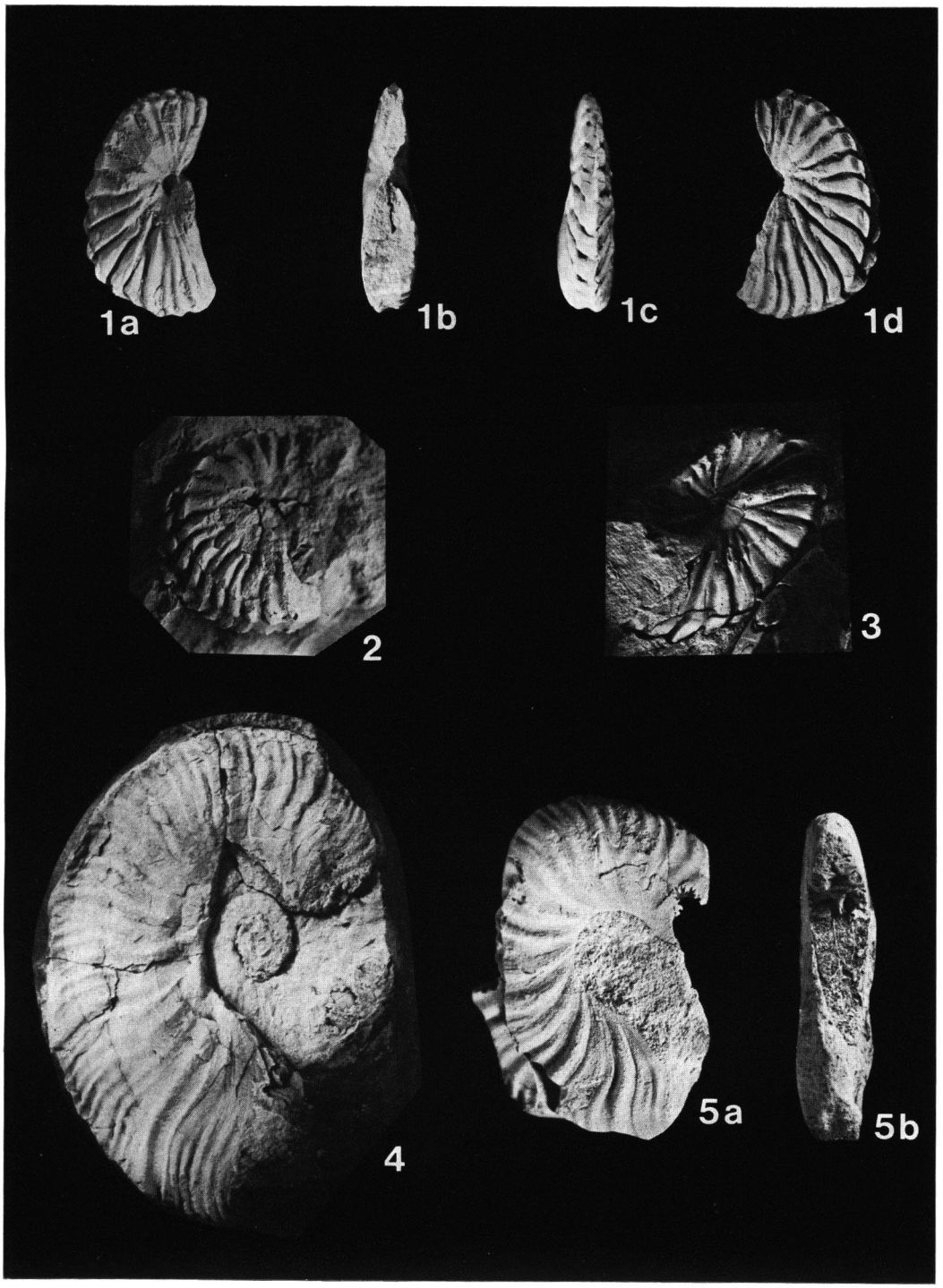
Fig. 1. *Pulchellia ishidoensis* YABE et SHIMIZU. SGE-1 from 621 (K. TANAKA coll.). Lateral (a, d), apical (b) and ventral (c) views, ×1.4.

Fig. 2. *Pulchellia ishidoensis* YABE et SHIMIZU. NSM-PM 9495 from loc. 621 (I. FUJIYAMA coll.). Lateral view, ×0.9.

Fig. 3. *Pulchellia ishidoensis* YABE et SHIMIZU. SGE-2 from loc. 621 (K. TANAKA coll.). Lateral view, ×0.9.

Fig. 4. *Pseudohaploceras japonicum* OBATA et MATSUKAWA sp. nov. NSM-PM 7297, paratype, from loc. 203 (K. OGAI coll.). Lateral view, ×0.9.

Fig. 5. *Pseudohaploceras japonicum* OBATA et MATSUKAWA sp. nov. NSM-PM 7296, holotype, from loc. 203 (M. FUTAKAMI coll.), Lateral (a) and apical (b) views, ×0.9.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Material: NSM-PM 9495, a specimen from Loc. SA-621, collected by I. FUJIYAMA. SEG-001 and -002, specimens from the same locality, collected by K. TANAKA.

Specific character: The shell is of a small size, being slightly over 35 mm in diameter. The whorl is much compressed, much involute and very narrowly umbilicate. The whorl section is roughly quadrate, showing the maximum whorl-breadth at the half of the height. The flanks are rather flattened. The venter is narrow and concave. The ventro-lateral shoulder is steep. The ribs are strong, nearly flattened at the top, forming a rectangle between the top and side, and are separated by interspaces of the same breadth as the ribs. The ribs spring from the umbilical margin, and occasionally bifurcate at the lower half of flank. Sometimes shorter ribs are intercalated. The ribs including shorter ones are slightly sinuous on the flank, prorsiradiate near the venter, forming a chevron there. In the outer whorl of the later stage the ribs gradually become slender and crowded. Double ventro-lateral clavi exist; the upper tubercles are stronger than the lower and the lower tubercles gradually become indistinct near the apertural end (e.g. 10–12 mm in height). The suture is unknown.

Measurements (in mm):

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
NSM-PM 9495	28.2(1)	3.9(0.14)	12.6	6.9	0.55
SGE-001	30.9(1)	3.2(0.10)	16.4	8.0	0.49
SGE-002	34.4(1)	4.7(0.14)	16.3	?	?

Comparison: The present species is similar in shell form and ornament to *Heinzia* (*H.*) *provincialis* (D'ORBIGNY) from the middle Barremian of Colombia, which was designated by BÜRGL, 1956 (p. 78, pl. 22, figs. 1–6) as the type species of the genus and subgenus. However, it has more numerous and delicate ribs, a narrower umbilicus and a more compressed whorl.

This species somewhat resembles *Pulchellia popenoei* ANDERSON (ANDERSON, 1938, p. 197, pl. 73, figs. 1, 2; MURPHY, 1975, p. 22, pl. 2, fig. 2, pl. 6, figs. 3, 4) from the Lower Barremian of California. It can be, however, distinguished by its less flexuous ribs and wider interspaces of ribs.

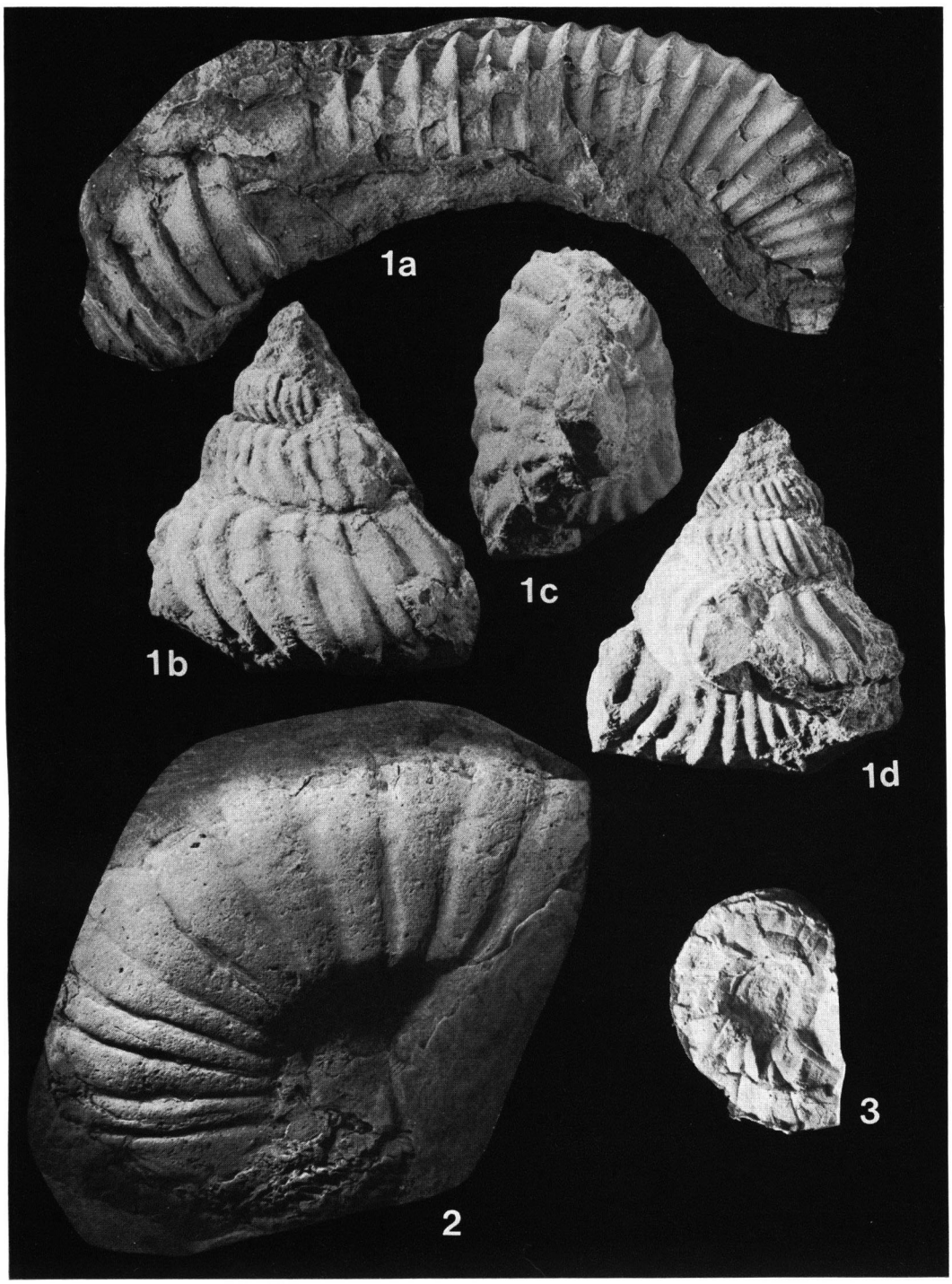
Occurrence: loc. SA-621, a muddy sandstone bed in the lower part of the Ishido Formation, about 4 km east of Koya, Saku-machi, Nagano Prefecture. This bed is

Explanation of Plate 3

Fig. 1. *Heteroceras* (*H.*) aff. *H. astieri* D'ORBIGNY. NSM-PM 7288 (a) and 7287 (b, c, d) from loc. 203 (a) and 307 (b, c, d) (7288; H. TSUDA and M. FUTAKAMI and 7287; M. MATSUKAWA coll.). Lateral view (a) of shaft, lateral (b, d) and apical (c) views of helicoid, ×0.5 (a) and ×0.9 (b, c, d).

Fig. 2. *Anagaudryceras* cf. *A. sacya* (FORBES). NSM-PM 9496 from loc. 803 (Y. SAKA and K. KOIZUMI coll.). Lateral view, ×1.4.

Fig. 3. *Lytoceras* sp. IGPS 22848 from north of Otomo (for its detailed location unknown, unrecorded by H. YABE and S. SHIMIZU) (H. FUJIMOTO coll.). Lateral view, ×1.4.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probably correlated with the Upper Hauterivian to the Lower Barremian. In addition to this species, *Simbirskites* (*Milanowskia*) sp., *Barremites* (*B.*) *difficilis*, etc. occurred from the same locality. Some molluscan shell as *Pterotrigonia* (*P.*) *hokkaidoana*, *Nanonavis* (*N.*) *yokoyamai*, etc. have also been found.

Family Desmoceratidae ZITTEL, 1895
Subfamily Puzosiinae SPATH, 1922
Genus ***Pseudohaploceras*** HYATT, 1900

Type species: *Ammonites liptoviensis* ZEUSCHNER 1856, by original designation.

Pseudohaploceras japonicum sp. nov.

Pl. 2, Figs. 4, 5a, b.

1976 *Pseudohaploceras* cf. *P. douvillei* (FALLOT), OBATA and OGAWA, *Bull. Natn. Sci. Mus.*, ser. C, vol. 2, no. 2, text-figs. 6–3.

1976 *Barremites* (*B.*) (?) aff. *B. difficilis* (D'ORBIGNY), OBATA *et al.*, *Ibid.*, no. 3, text-figs. 6–4.

Material: NSM-PM 7296, holotype, collected by M. FUTAKAMI; NSM-PM 7297, paratype, collected by K. OGAI. These two specimens have been obtained from loc. 203.

Description: The above specimens are large; about 59 mm and 79 mm in diameter, respectively. The shell is higher than broad and fairly narrowly umbilicated. Involution of the whorl is moderate. The umbilicus is surrounded by steep walls, which are nearly perpendicular to the flank and are sharply angular at the rim. The breadth is maximum at about one-third of the flank from the umbilical margin. Flanks are almost flattened but gradually converge into a gently arched narrow venter. There are numerous, fairly crowded, sinuous ribs on the flanks. They cross the venter, forming a gentle arch there, and generally consist of stronger and weaker ones. The stronger ribs start at or very near the umbilical margin, while the weaker ones being at about one-third or two-thirds of the flanks from the umbilicus. Some ribs are branched at the umbilical edge. The ribs are separated by interspaces as wide as themselves. The constrictions are frequent; several in half volution. They are nearly parallel to the ribs. The suture is rather complicated, but details are uncertain because of imperfect preservation (e.g. NSM-PM 7296).

Measurements (in mm):

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
NSM-PM 7296	58.9(1)	16.0(0.27)	—	—	—
			20.0	11.2	0.55
NSM-PM 7297	79.0(1)	20.6(0.26)	35.0	—	—

Explanation of Plate 4

Fig. 1. *Phylloceras* sp. OG-1 from loc. 200R (K. OGAI coll.). Lateral (a) and apical (b) views, ×0.5.


1a
1b

Remarks: This species is similar to *Haploceras liptoviense* (ZEUSCHEN) (UHLIG, 1883, p. 229–230, pl. 17, figs. 9, 16–18; pl. 18, figs. 1, 3, 4, 6) from the Wernsdorfer Schichten in its shell form and numerous, fairly crowded, sinuous ribs. The constrictions of the latter are, however, much broader and deeper, and are associated with a higher elevation. Furthermore, the umbilical wall is nearly perpendicular to the flank in the former, while rather crator-like in the latter.

The umbilical edge of the present species has some resemblance to that of *Barremites* (*B.*) *difficilis* (D'ORBIGNY) (UHLIG, 1883, p. 222, pl. 17, figs 1, 2) from the Wernsdorfer Schichten in its steep wall.

Pseudohaploceras nipponicum SHIMIZU (1931, p. 27, pl. 1, figs. 17–19), an Aptian species from Japan, has some similarity to the present species in the general features of shell form and ornamentation, but differs in its smaller umbilicus, stronger constrictions and weaker ribbing.

In short, the present specimens represent a new species of *Pseudohaploceras* which is characterized by a steep umbilical wall.

Occurrence: Loc. SA-203, a muddy sandstone bed in the upper part of the Ishido Formation, about 1 km north of Sebayashi, Mamono-zawa, Tano-gun, Gunma Prefecture. Its stratigraphic position probably assigned to the Upper Barremian. In addition to this species *Barremites* (*B.*) aff. *B. strettostoma*, *Heteroceras* (*H.*) aff. *H. astieri*, etc. occurred from the same locality. Some molluscan shells such as *Pterotrigonia* (*P.*) *hokkaidoana*, *Anisomyon* sp., etc. were also obtained from there.

Order Nautilida, AGASSIZ, 1847
Superfamily Nautilaceae DE BLAINVILLE, 1825
Family Cymatoceratidae SPATH, 1927
Genus ***Heminautilus*** SPATH, 1927

Type species: *Nautilus saxbii* MORRIS 1848, by original designation.

Heminautilus cf. ***H. lallierianus*** (D'ORBIGNY)

Pl. 5, Fig. 1a, b; Pl. 6, Fig. 1; Text-fig. 3.

Compare:

1916 *Nautilus lallierianus* DOUVILLÉ, *Mem. Acad. Sci., Inst. France*, ser. 2, vol. 54, p. 129, pl. 17, figs. 2–6.

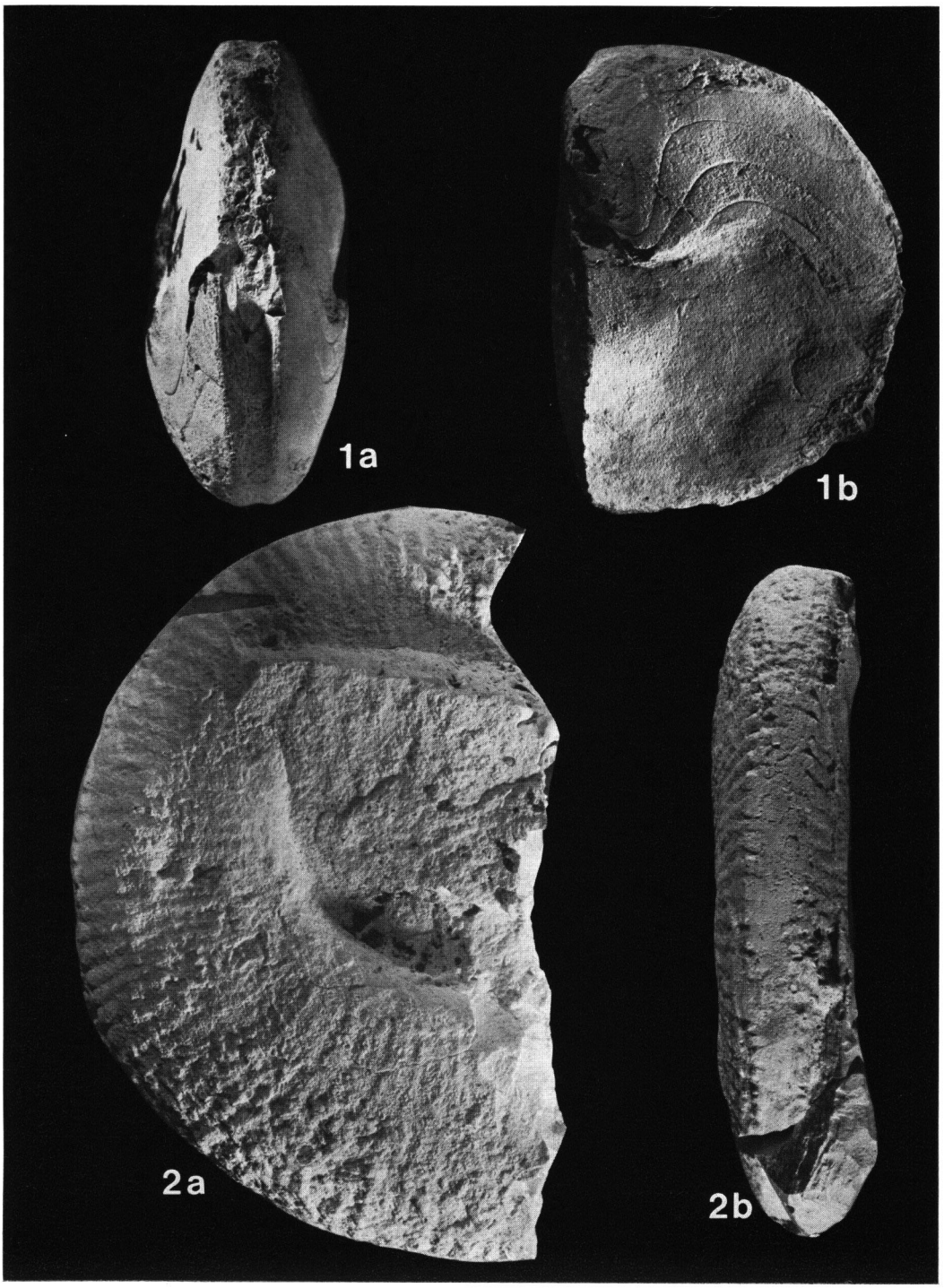
Material: SH-1, a specimen from Loc. 203, collected by E. SHIMIZU. A plaster cast of the same specimen is preserved in the National Science Museum, with prefix NSM-PM 9381.

Description: The shell is medium and involute. The whorl section is compressed and broadest at the umbilical shoulder, showing roughly flattened but slightly inflated

Explanation of Plate 5

Fig. 1. *Heminautilus* cf. *H. lallierianus* (D'ORBIGNY). SH-1 from loc. 203 (E. SHIMIZU coll.). Ventral (a) and lateral (b) views, ×0.9.

Fig. 2. *Shasticrioceras* aff. *S. patricki* MURPHY. NSM-PM 9376 from loc. 200 (K. OGAI and M. MATSUKAWA coll.). Lateral (a) and ventral (b) views, ×0.7.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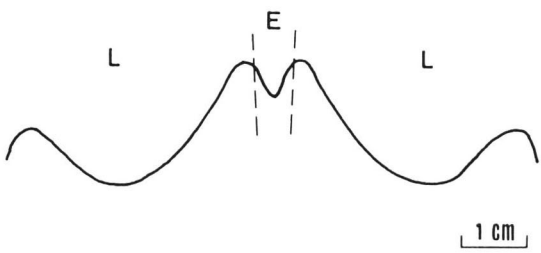

Text-fig. 3. *Heminautilus* cf. *H. lallierianus* (D'ORBIGNY). External suture of the Sanchu specimen, NSM-PM 9381, from loc. 203, at whorl-height of 37 mm.

flanks which are rapidly convergent toward the venter. The ventral shoulders are angular. The venter is very narrow and concave with a distinct groove. The umbilical shoulder is rounded and the umbilicus is extremely narrow. The numerous fine costae are discernible on the venter and in the ventral side of flanks of an internal mould of the shell. The suture is observed in the inner half of the preserved shell (Text-fig. 3). It is sinuous and characterized by a broad and deep lateral lobe and a narrowly rounded saddle on the umbilical shoulder. It shows a rather subangular saddle on the ventral shoulder, forming a small V-shaped lobe on the venter.

Measurements (in mm):

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
SH-1	74.4(1)	4.3(0.06)	42.3	32.0	0.76

Remarks: The present species is similar to *Heminautilus lallierianus* (D'ORBIGNY) (DOUVILLÉ, 1916, p. 129, pl. 17, figs. 2–6) from the Neocomian of eastern Suez in the outline of whorl section and the surface ornamentation. The illustrated young specimens of *Heminautilus lallierianus* (DOUVILLÉ, 1916, pl. 17, figs. 2–4) have, however, the ribbing of somewhat different strength from the adult specimens (DOUVILLÉ, 1916, pl. 17, figs. 5, 6). The feature of the present specimen closely resembles that of the adult specimen from Suez at nearly the same growth stage. *Heminautilus lallierianus* reported by OBATA and OGAWA (1976, p. 103, fig. 7a-c) from the Barremian Arida Formation somewhat resembles the present species in the shell form and the details of the suture as seen in illustration (fig. 7b), but it has a wider and much shallower groove. *Heminautilus saxbii* (MORRIS) from the Aptian of Lower Greensand (KUMMEL, 1956, p. 434–438, pl. 10, figs. 1, 2) shows a similar shell form to the present species, but its flanks are more flattened and its venter is much more shallowly grooved. *Heminautilus tyoshiensis* (YABE et OZAKI, 1953, p. 55–61, pl. 1; OBATA, HAGIWARA and KAMIKO, 1975, pl. 2, fig. 2) is different from the present species in having a wider

Explanation of Plate 6

Fig. 1. *Heminautilus* cf. *H. lallierianus* (D'ORBIGNY). SH-1 from loc. 203 (E. SHIMIZU coll.). Lateral view, ×0.9.

Fig. 2. *Shasticrioceras* aff. *S. patricki* MURPHY. NSM-PM 9377 probably from loc. 200 (T. TAKAHASHI coll.). Lateral view, ×0.5.


1
2

venter. In the former species the ventral area is widely sulcate, and has an angular shoulder, flattened gentle slopes, a narrow median bottom and numerous rursiradiate lirae. *Heminautilus akatsui* described by MATSUMOTO (1980, p. 328–330, fig. 4; pl. 37, fig. 1a-d), atypical example of the genus, from the Lower Albian Yatsushiro Formation is distinguished from the present species in its rather stumpy type of shell; the whorl is nearly as high as broad, and has a subtrapezoidal cross-section in late-stage (about 10 mm in diameter).

Occurrence: Loc. SA-203, in Nakazato Village, Tano-gun, Gunma Prefecture. The stratigraphic horizon is probably assigned to the lower part of the Upper Barremian.

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