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Geological Age of the Cretaceous Ishido Formation, Japan

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Introduction

In the Kwanto massif at the northern extension of the Chichibu belt of the Outer zone of Southwest Japan there is a narrow area occupied mostly by Mesozoic rocks, 40 km long and 2–4 km broad, which extends from Ohinata-mura, Minamisaku-gun, Nagano Prefecture to Ogano-machi, Chichibu-gun, Saitama Prefecture in the direction of WNW-ESE, subparallel to the general trend of the Paleozoic and other rocks. The Mesozoic sequence exposed there is geologically important, because it occupies just the intermediate situation between Southwest and Northeast Japan. This narrow area has been said to represent a graben ever since HARADA (1890) called it the Sanchu graben.

The stratigraphy of the Cretaceous rocks in the Sanchu area was investigated by many authors, *i.e.*, 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 (1975). The fossil fauna was studied by YABE, NAGAO and SHIMIZU (1926), YABE and SUGIYAMA (1930), EGUCHI (1951), TANAKA and SHIBATA (1961), TANAKA (1965), HAYAMI (1965, 66), HAYAMI and ICHIKAWA (1965), and HAYAMI and NAKAI (1965). The fossil flora was studied by YOKOYAMA (1894) and OISHI (1940).

In spite of such numerous investigations as mentioned above, the geological age

of the Cretaceous sequence was inaccurate biostratigraphically. However, as our research work progressed, we have accumulated ammonite specimens enough to discuss the age of Cretaceous rocks. Part of our results is given here. The present paper describes certain ammonite species and discusses the ammonite biostratigraphy of the Ishido Formation, the lowermost formation of the Cretaceous sequence exposed in the eastern part of the Sanchu area, although the studied area is limited in 10 km long and 2–4 km broad, which extends from Nakazato-mura, Tano-gun, Gunma Prefecture to Ogano-machi, Chichibu-gun, Saitama Prefecture.

We wish to record here a debt of gratitude to the following persons who helped this study in various ways: Dr. Itaru HAYAMI of the University of Tokyo identified the pelecypod fossils; Dr. Tatsuaki KIMURA of Tokyo Gakugei University identified the plant fossils; Miss Reiko FUSEJIMA of the National Science Museum read through the manuscript and typed it up for print. The study was in part financially supported by the Grant in Aid for Scientific Researches, defrayed from the Ministry of Education.

Stratigraphic Notes

The stratigraphic sequence of the area studied is summarized in descending order as follows (see also Fig. 1).

E. Sanyama Formation:— Described below.

—unconformity—

D. Sebayashi Formation:— Described below.

C. Ishido Formation:— Described below.

—unconformity—

B. Kamiyoshida Formation:— It is composed mainly of thick alternation of chert, slate and sandstone. The chert occasionally contains thin limestone beds. Late Triassic conodonts*, such as *Epigondolella postera, E. abneptis* and *E. spatulata*, were obtained from the chert and limestone. Thus the age of the formation is assigned to lower Norian.

—unconformity—

A. Mamba Formation:— It is composed mainly of schalstein and limestone, intercalated with chert, lenticular limestone and slate. Fusulinids** such as *Cancellina nipponica, Pseudofusulina vulgaris, P. kraffti, Fusulinella* sp. and *Millerella* sp. were obtained from the limestone lenses at several localities. The age of the Mamba Formation probably ranges from Middle Permian to Upper Carboniferous.

The Cretaceous stratigraphy of the area is described in the following lines. The individual columnar sections are shown in Fig. 2 with the indication of the horizons which yielded the ammonite species. The fossil localities are shown in the geological map (Fig. 3).

* Fossils were identified by Mr. H. IGO of Tokyo Gakugei University.

** Fossils were identified by the second author (M. MATSUKAWA).

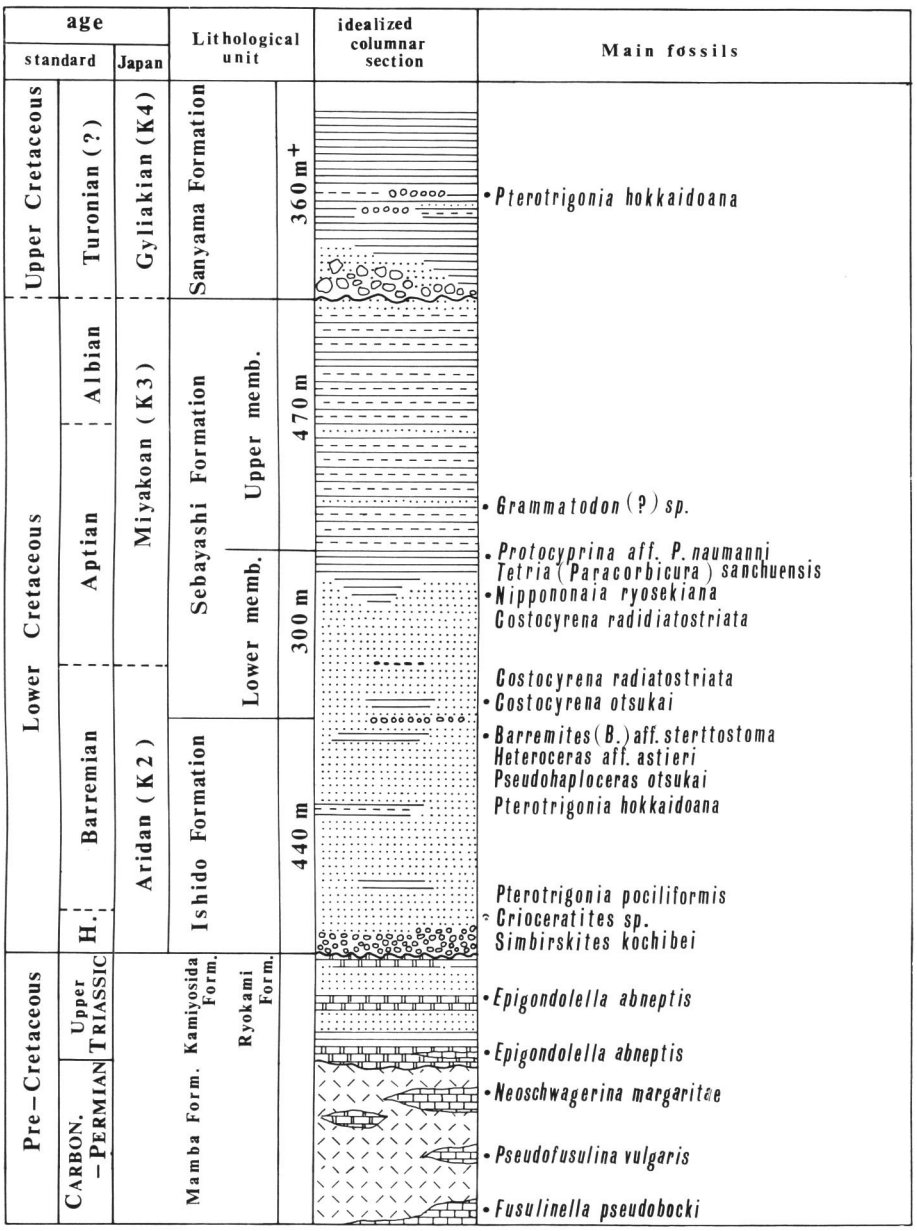


Fig. 1. Stratigraphic sequence of the southeastern part of the Sanchu area. Circles indicate the horizons which yielded the fossil species.

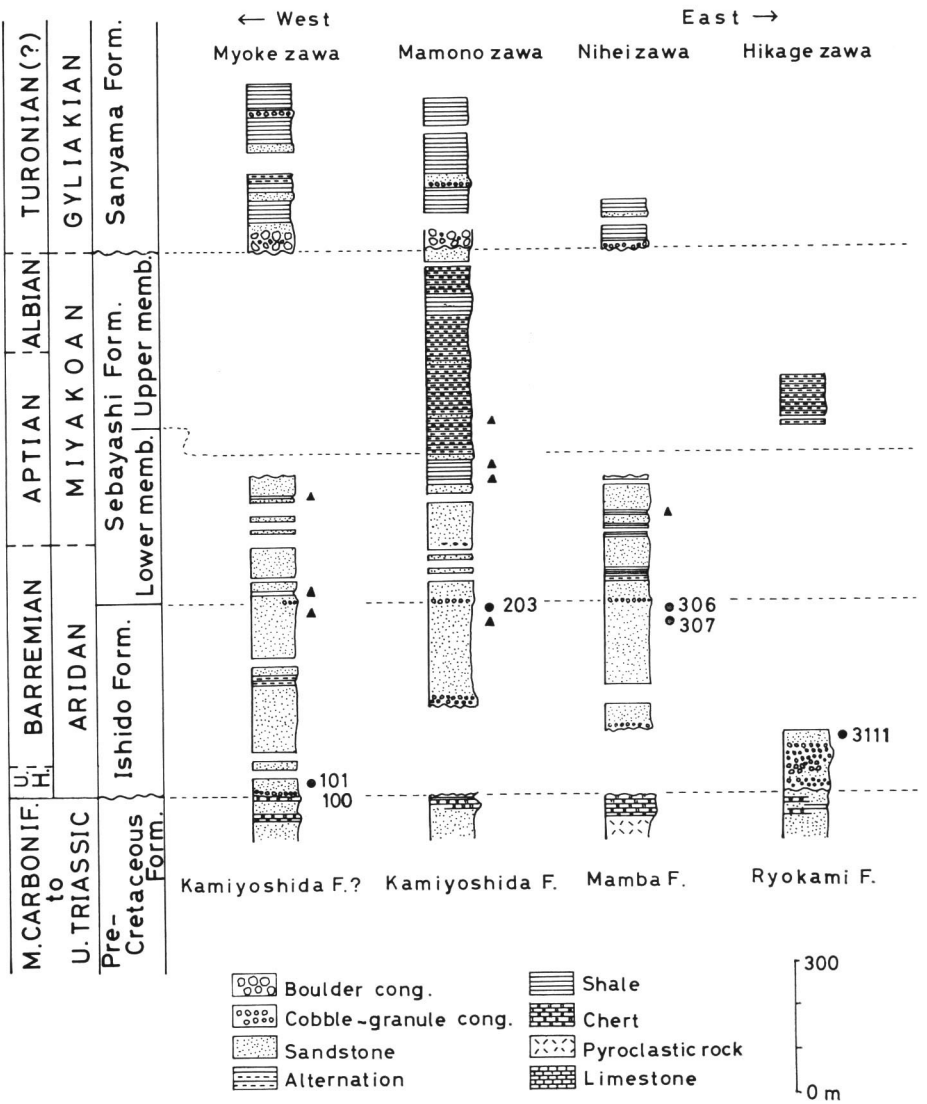


Fig. 2. Geological columnar sections with the indication of the horizons which yielded the ammonite species (circles) and the other molluscan species (triangles).

C. Ishido Formation

Type locality: Ishido, Ohinata-mura, Minamisaku-gun, Nagano Prefecture.
Thickness: 440 m along the Mamono-zawa.

The formation, designated by YABE, NAGAO and SHIMIZU in 1926, has its type locality in the western part of the Sanchu area, although the similar lithofacies and fossils are recognized in the eastern part we surveyed.

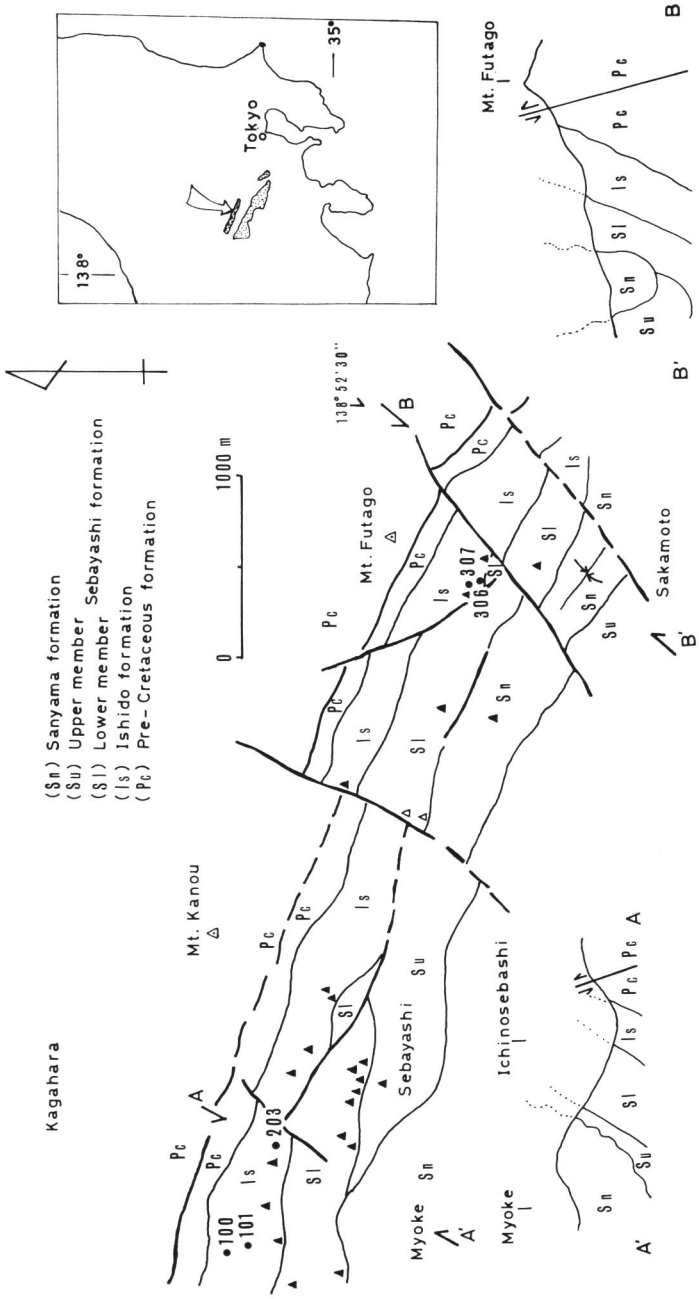


Fig. 3. Geological map with the indication of the fossil cephalopods (circles) and the other molluscan (triangles) localities.

The Ishido Formation rests on the older formations with conspicuous clino-unconformity. The formation begins with coarse sediments at the base, becoming finer-grained upward. The basal part of the formation is composed of coarse-grained sandstone, granule conglomerate, and ill-sorted conglomerate consisting mainly of subangular chert cobbles derived probably from the Chichibu Supergroup. The thickness of the conglomerate varies laterally, *e.g.*, being 5 m at Iwane-zawa and 100 m at Hikage-zawa.

Dark blue medium- to fine-grained sandstone, overlying the basal conglomerate, constitutes the main part of the formation. From the lower part of the sandstone a few ammonites and *Pterotrigonia pociliformis* were obtained. The sandstone is locally intercalated with black shale and thinly alternating sandstone and shale. The fossiliferous parts of the sandstone are more or less muddy in facies.

We have collected the following marine molluscan fossils from the Ishido Formation: *Astarte* (*A.*) *costata, A.* (*A.*) *subsenecta, A.* (*Trautsholdia*) *minor, A.* (*Yabea*) *shinanoensis, Anisomyon annulata, Arctostrea carinata, A.* sp., *Entolium sanchuensis, E. yatsushiroensis, Gervillia* (*G.*) *forbesiana, Gervillaria haradae, G.* sp., *Grammatodon* (*Nanonavis*) *yokoyamai, G.* (*G.*) sp., *Isognomon* (?) sp., *Leptosolen* sp., *Limatula* sp., *Panopea* (*Myopsis*) *plicata, P.* sp., *Pinna* cf. *robinaldina, Plectomya aritagawana, Protocardia hiraigaensis, Pterotrigonia hokkaidoana, P. pociliformis, Lycettia* sp., *Ptychomya densicostata, P.* sp., *Trigonia* (*T.*) sp., Arcticidae gen. et sp. indet., Tancrediidae gen. et sp. indet., *Dentalium* sp.

From the upper part of the formation at a few localities we have obtained several species of ammonites. We will describe two of them in the succeeding chapter and will discuss the meaning of the ammonite specimens under geological age.

D. Sebayashi Formation

The formation is widely distributed in the area surveyed. It is about 700 m thick, and is composed of conglomerate, sandstone, shale and alternation of sandstone and shale. The formation is divided into two members, lower and upper.

a) Lower member

Type locality: Between Ichinosebashi and the entrance to Hachiman-zawa along Mamono-zawa, Nakazato-mura, Tano-gun, Gunma Prefecture. Thickness: 300 m.

The lower member represents a small semi-cycle of sedimentation. The basal part, conformably covering the Ishido Formation, consists of conglomerate and sandstone. The conglomerate is composed of fairly well sorted, rounded pebbles and cobbles of chert and sandstone. The conglomerate is generally thin, and sometimes laterally grades into coarse-grained sandstone.

The middle part is marked by dark gray to white, medium-grained massive sandstone which becomes gradually finer upward, intercalated with thin layers of sandy shale or alternation of sandstone and shale. Ripple marks and sole marks are fairly abundant.

The upper part is marked by shale which is partly sandy and occasionally fossiliferous. Fossiliferous parts of the shale are several meters thick, yielding limnic,

brackish and neritic molluscs and plants, as represented by the following species: *Astarte shinanoensis, Costocyrena otsukai, C. radiatostriata, C.* (?) sp., *Isognomon* (*I.*) *sanchuensis, I.* (?) sp., *Nippononaia ryosekiana, Panopea* sp., *Protocyprina* aff. *naumanni, Tetoria* (*Paracorbicula*) *sanchuensis, T.* (*P.*) sp., *Sphaerium* (?) sp., Neomiodontidae gen. et sp. indet., *Cerithium*(?) sp., *Glauconia*(?) spp., *Purpuroidea*(?) *japonica, Tylostoma miyakoense*; *Osmunda takezakii, Cladophlebis acutipennis, C. argutula, C. nathorsti, Sphenopteris* cf. *goepperti, Onychiopsis elongata, O.* sp., *Ptilophyllum pecten, Zamiophyllum buchianum, Nilssoniopteris*(?) sp., *Nilssonia scaumburgensis, Brachyphyllum japonicum.*

b) Upper member

Type locality: Sebayashi, Nakazato-mura, Tano-gun, Gunma Prefecture. Thickness: 470 m.

The upper member consists mainly of thinly alternating sandstone and shale. It is sometimes intercalated with massive, medium-grained sandstone and several thick beds of shale. The alternating part shows graded bedding and cross-lamination which are helpful to detect the upper and lower sides of bed. The upper member is very poor in fossils, but a shale bed in the lower part yielded *Grammatodon*(?) sp. and a few pelecypods.

E. Sanyama Formation

Type locality: Upper reaches of Myoke-zawa, Nakazato-mura, Tano-gun, Gunma Prefecture. Thickness: 360 m+.

The Sanyama Formation represents two cycles of sedimentation, each beginning with basal conglomerate, grading upward into sandstone, and ending with shale. The lowermost conglomerate covers the Ishido and Sebayashi Formations with clino-unconformity. The conglomerate is not well sorted, consisting mainly of pebbles and cobbles of granite, diorite, sandstone, chert and shale. Its thickness changes laterally.

Medium- to fine-grained sandstone overlies the conglomerate. Graded bedding and cross-lamination are frequently observed in the sandstone, which grades into black shale upward. The shale is the thickest of all constituent rocks of the Sanyama Formation, though it sometimes grades into fine-grained sandstone. Lamination and current markings are observed in the fine-grained sandstone.

About 150 m above the base of the Sanyama Formation there is a thin bed of conglomerate, the upper conglomerate, 30 to 50 cm thick, not well sorted, consisting chiefly of angular gravels of chert and limestone, with occasional sandstone and shale.

Fossils are rare in the Sanyama Formation, but we obtained a few molluscs, such as *Pterotrigonia hokkaidoana* and *Arctostrea* sp., from the sandstone, and one gastropod and some plant fragments from the shale.

Systematic Description

Superfamily Desmoceratacea

Family Desmoceratidae ZITTEL, 1895

Subfamily Eodesmoceratinae WRIGHT, 1955

Genus *Barremites* KILIAN, 1913

Type species. *Ammonites difficilis* D'ORBIGNY, 1841, from the Barremian deposit of France, by original designation.

Remarks. We follow WRIGHT (1955) in assigning *Barremites* to the subfamily Eodesmoceratinae of the Desmoceratidae. After WRIGHT distinguished the two subgenera *Barremites* and *Raspailiceras* represented by *Ammonites cassida* RASPAIL, 1831 as the type species, DIMITROVA (1967) added two more subgenera, namely, *Cassidoiceras* represented by *Haploceras cassidoides* UHLIG, 1883 as the type species, and *Reboulites* represented by *Puzosia issarpayensis* KILIAN et REBOUL, 1915 as the type species.

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

Pl. 1, fig. 1; Pl. 2, fig. 4; Fig. 4.

Compare.

1907. *Haploceras strettostoma* UHLIG, *Denkschr. K. Akad. Wiss., Wien*, Math.-Nat. Kl., vol. 46, p. 225, pl. 17, figs. 3, 4, 8, 15.

1909. *Desmoceras strettostoma* KARAKASCH, *Trav. Soc. Imp. Nat. St. Pétersb., Sec. Géol. Min.*, vol. 32, no. 5, pl. 5, figs. 3–5; pl. 6, fig. 5; pl. 24, fig. 19.

Material. NSM-PM 7281–82, collected by H. TSUDA; NSM-PM 7283–84, collected by M. MATSUKAWA; NSM-PM 7285–86, collected by Y. OGAWA. All specimens were obtained from Loc. SA-203.

Description. All individuals are below 25 mm in diameter. In some specimens (*e.g.*, PM 7281) the last half whorl is unseptate. The shell has an umbilicus of very small size, showing moderate involution. The umbilicus is rather deep, surrounded by high and steep walls, which are nearly perpendicular to the flank and are sharp and angular at rim. The whorl is high and much compressed in the breadth/height ratio, becoming more compressed with growth. The breadth is maximum near the umbilical margin (*e.g.*, PM 7282–83), but sometimes at about one-fourth of the flank from it

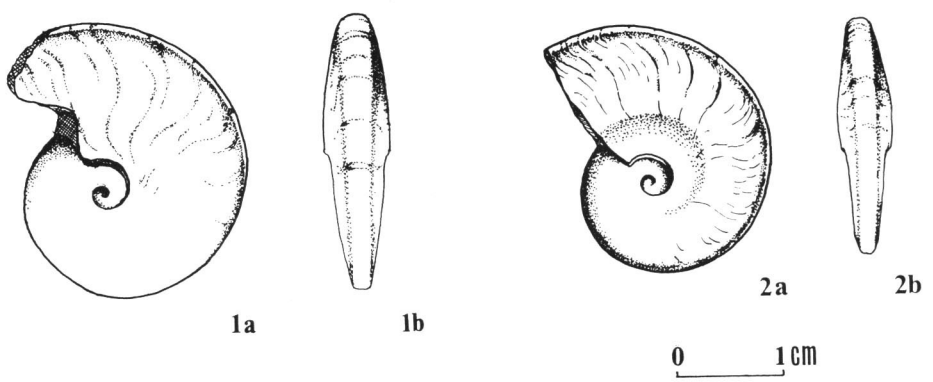


Fig. 4. Restored two figures of *Barremites* (*B.*) aff. *strettostoma*.
Lateral (1a) and ventral (1b) views of NSM-PM7282 from loc. SA-203.
Lateral (2a) and ventral (2b) views of NSM-PM7281 from the same locality.

(*e.g.*, PM 7281 and PM 7284). Flanks are almost flattened but gradually converge into the gently arched narrow venter, forming subangular shoulder.

Shell is nearly smooth, but faint riblets or lirae are observable. They are sinuous to falcoid, apparently arranged close to each other, counting about 25 in number on the last half whorl. Some of them start from the umbilical margin, others from a little above it; they are rather conspicuous on the flank, but become feeble on the venter, forming gentle arch there. There is no distinct constriction.

The suture is rather simple. Details are uncertain because of imperfect preservation (*e.g.*, PM 7282–83).

Measurements.

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
NSM-PM 7281	25.0 (1)	3.8 (0.15)	12.5 (0.50)	4.5 (0.18)	0.36
	—	—	9.9 (—)	3.8 (—)	0.39
NSM-PM 7282	23.1 (1)	4.1 (0.18)	11.3 (0.49)	—	—
NSM-PM 7283	20.8 (1)	2.8 (0.13)	9.7 (0.47)	—	—
	—	—	7.0 (—)	4.8 (—)	0.60
NSM-PM 7285	17.1 (1)	2.5 (0.15)	9.2 (0.54)	4.8 (0.28)	0.52

Discussion. The two syntypes of *Haploceras strettostoma* by UHLIG (1907, pl. 17, figs. 3, 4), from the Wernsdorfer Schichten, are small in size, and seem to resemble the Japanese specimens in the high-whorled shell form, moderate involution and general feature of the ornament. Estimated from the figure by UHLIG, the umbilicus size is 10 to 11 percent of the total diameter, and the breadth to height ratio is calculated as 0.41. Thus, the Caucasian specimens seem to be distinct from the Japanese specimens in having somewhat smaller umbilicus and having the maximum breadth near the middle of the flank.

The several hypotypes of *Desmoceras strettostoma* by KARAKASCH (1909, pl. 5, figs. 3–5; pl. 6, fig. 5), from the Crimea Peninsula have the whorl section similar to the young stage of the Japanese specimens, the breadth/height ratio being 0.46 to 0.60 and the umbilicus size 10 to 16 percent of the total diameter. However, the ventro-lateral periphery is rather rounded in the Crimean specimens.

To sum up, the possibility that the described specimens represent a new species cannot be denied, though we hesitate to propose a new specific name before larger specimens become available. Our specimens are all small in diameter, and so a precise comparison with those of the other species is impossible for the present.

Occurrence. Loc. SA-203, a fine-grained sandstone bed in the upper part of the Ishido Formation, about 1 km north of Sebayashi, Mamono-zawa, Nakazato-mura, Tano-gun, Gunma Prefecture. The horizon is probably correlated with the lower part of the Upper Barremian. In addition to this species, *Anahamulina* aff. *subcylindrica, Pseudohaploceras* (?) *otsukai*, etc. occur at the same locality. Some molluscan shells such as *Pterotrigonia hokkaidoana, Anisomyon annulata*, etc. are also found at this locality.

Superfamily Ancyloceratacea
Family Heteroceratidae HYATT, 1900
Genus *Heteroceras* D'ORBIGNY, 1850

Type species. *Heteroceras emericianum*, subsequently designated by MEEK, 1876.

Remarks. Two subgenera are distinguished; *Heteroceras* and *Argvethites* ROUCHADZÉ, 1933 represented by *H.*(*A.*) *lashense* as the type species.

Heteroceras (*Heteroceras*) sp. aff. *astieri* D'ORBIGNY

Pl. 1, figs. 4, 7; Fig. 5.

Compare.

1850. *Heteroceras astieri* D'ORBIGNY, Prodrome de Pal. Stratig. Et., 19, no. 663, p. 142.
1851. *Heteroceras astieri* D'ORBIGNY, *Journ. de Conch.*, vol. 2, p. 217, pl. 4.
1888. *Heteroceras astieri* KILIAN, Thèse Fac. Sci., Paris, pl. 4.

Material. NSM-PM 7287, a helical specimen from Loc. SA-307, collected by M. MATSUKAWA. NSM-PM 7288, a plaster cast of the curved shaft from Loc. SA-203, collected by H. TSUDA, M. FUTAKAMI and K. OGAWA.

Description. The shell is large for the genus. It consists of several helical whorls followed by long slightly curved shaft. The helix is left-turned around the axis. The general outline of the helix, which is moderate in size, is roughly triangular, with an apical angle of 65°. An exact outline of the apex is uncertain. The main helical whorls are contiguous, more or less embracing each other. The whorl itself is rounded on flanks of the helix and subcircular in section. The umbilicus is narrow, being smaller than the breadth of the whorl.

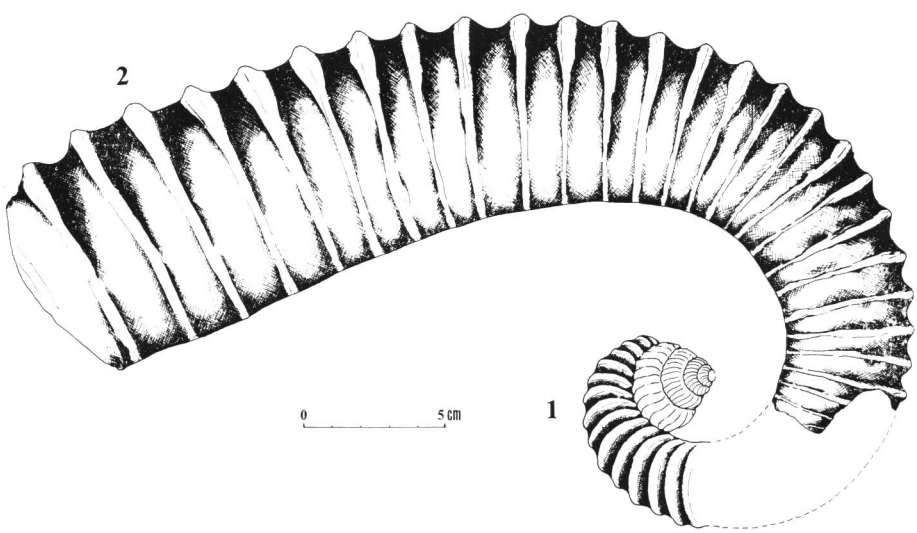


Fig. 5. Restored figure of *Heteroceras* (*H.*) aff. *astieri*.
Helical part (1) is based on NSM-PM7287 from loc. SA-307.
Curved shaft (2) is based on NSM-PM7288 from loc. SA-203.

The main helical whorl is ornamented with rather numerous, oblique, gently flexuous ribs which are about 12 in number at the last half of the helix. The distinct ribs are simple, concave and are separated by the interspaces which are as narrow as the ribs.

The curved shaft seems to be at the same level with the base of helix. The whorl becomes loosely coiled where it succeeds the helical part. In unhelicoid later part the whorl seems to be compressed, and the almost straight and radial ribs are rather narrow but strong, and are separated by broader interspaces than the ribs. The whorl height increases rapidly with growth. The suture is unknown.

Measurements.

NSM-PM 7287

Maximum whorl height of the preserved helix; ca. 24.4 mm.

About 3/4 whorl anterior; height 19.8 mm, breadth ca. 16.0 mm.

Height of the total helix; 63.0 mm.

NSM-PM 7288

Whorl height of the later part of the shaft; ca. 80.0 mm.

Discussion. The present specimens are similar to, but larger than, the KILIAN's specimen (1888, pl. 4) illustrated by ROMAN (1938, p. 357, pl. 35, fig. 339) as *Heteroceras astieri* D'ORBIGNY. *H. astieri* from the Upper Barremian of France has, however, a different type of ribbing. The dense and rather flexuous ribs, instead of sparse and straight ones, are predominant except on the terminal hook. In the later part of the shaft of *H. astieri* some ribs are bifurcated at the middle of the flank. ROMAN's figure of *H. astieri* is also smaller than the Japanese specimens, showing the right-turned helix with an apical angle of 50° (1938, p. 357, pl. 35, fig. 339a).

The figure of *Heteroceras* (*H.*) *tardieui* KILIAN (1907–13) illustrated by WRIGHT (1957, p. L212, fig. 241–4) seems to have the right-turned helix but is similar in shell form and ornament to ROMAN's figure (1938, pl. 35, fig. 339), suggesting that the same specimen was reversely printed.

An illustrated specimen of *Heteroceras astierianum* D'ORBIGNY from the Lower Aptian of Georgia (LUPPOV and DRUSHCHITS, 1958, p. 105, pl. 49, fig. 3) has much smaller helix and shaft than the Japanese specimens. The ribs of the former are densely arranged and frequently bifurcated at the curved part of the shaft.

An example of *Heteroceras bifurcatum* D'ORBIGNY (1851, p. 221, pl. 3, figs. 2, 3) from Bulgaria illustrated by DIMITROVA (1967, p. 64, pl. 39, fig. 2) is much smaller than the Japanese specimens. The ribs of the former are distinctly bifurcated on the inner flank of the earlier stage.

Although the described specimens probably represent a new species, we hesitate to propose a new specific name because of the imperfectness of our material and of our insufficient knowledge of the foreign material.

Occurrence. Loc. SA-307, about 500 m south of Futagoyama, Sakamoto-zawa, Ogano-machi, Chichibu-gun, Saitama Prefecture. Loc. SA-203 described on p. 129. Both are in the upper part of the Ishido Formation. The horizon is probably correlated with the lower part of the Upper Barremian. At Loc. SA-307 the bed which

yielded the ammonite contains many molluscan shells as represented by the following species we collected: *Astarte* (*Yabea*) *shinanoensis, Anisomyon annulata, Entolium sanchuensis, Gervillaria haradae, Pterotrigonia hokkaidoana, P. pociliformis, Lycettia* sp., Tancrediid, *Dentalium* sp.

Geological Age

YABE, NAGAO and SHIMIZU (1926) described four ammonite species from their Kawarazawa Group in the southeastern part of the Sanchu area and seven species from the underlying Ishido Group (YABE et al., 1926) in the northwestern part of the area. In connection with the discussion of the marine Lower Cretaceous deposits of Japan, SHIMIZU (1931) mentioned three ammonite-bearing zones in the Sanchu area, and he regarded the zones as indicative of Lower Aptian to Upper Hauterivian. Since then, many stratigraphers investigated the area and listed cephalopods, but no paleontological description was done for the Cretaceous ammonites.

In the course of our study of the southeastern part of the Sanchu area, we discriminated two ammonite-bearing horizons in the Ishido Formation. The fossil species and their localities are listed in Table 1. From the upper fossiliferous bed we have obtained several important ammonites such as *Heteroceras* aff. *astieri, Heteroceras* sp., *Pseudohaploceras*(?) *otsukai, Anahamulina* aff. *subcylindrica, Barremites* aff. *strettostoma*. Generally speaking, *Heteroceras* and *Pseudohaploceras* range from Barremian to Aptian, while *Anahamulina* and *Barremites* range from Hauterivian to Barremian (WRIGHT, 1957). Therefore, the assemblage of these genera safely indicates Barremian age.

Heteroceras astieri is regarded as a zonal index of the lower Upper Barremian in Europe, Caucasus, America and Colombia (BUSNARDO, 1965). *Barremites strettostoma*, also an important index of the lower Upper Barremian in Caucasus (ERISTAVI and KHALILOV, 1961), is known to occur in the lower part of the Upper Barremian along the route of Angle, the strato-type locality in France (BUSNARDO, 1965). Accordingly, the upper part of the Ishido Formation can be assigned to the lower zone of the upper Barremian.

From the lower fossiliferous bed we have obtained *Crioceratites* (*Emericiceras*)(?) sp., *Hoplocrioceras*(?) sp., etc. This assemblage suggests the lower zone of the Lower Barremian (BUSNARDO, 1965). YABE, NAGAO and SHIMIZU (1926) described *Simbirskites kochibei* from Ishido, the northwestern part of the Sanchu area. Since *Simbirskites* species are regarded as zonal indices of the Upper Hauterivian (KEMPER et al., 1974), the possibility that the Upper Hauterivian deposits exist also in the lower part of the Ishido Formation cannot be denied.

Concluding Remarks

Two species of the Barremian ammonites, *Heteroceras* aff. *astieri* and *Barremites*

Table 1. List of Neocomian ammonites from the Ishido Formation

	Specific name	localities
1.	*Phyllopachyceras* aff. *infundibulum* (D'ORBIGNY)	loc. 203
2.	*Calliphylloceras* (?) sp.	loc. 203
3.	Desmoceratid (?) gen. et spp. indet.	loc. 203
4.	**Barremites* (*B.*) aff. *strettostoma* (UHLIG)	loc. 203
5.	**Barremites* (*B.*) (?) sp.	locs. 203, 307
6.	*Barremites* (*B.*) (?) aff. *difficilis* (D'ORBIGNY)	loc. 203
7.	**Pseudohaploceras* (?) *otsukai* (YABE et SHIMIZU)	loc. 203
8.	*Pseudohaploceras* (?) sp.	loc. 203
9.	*Aconeceras* sp.	loc. 203
10.	*Simbirskites* (?) *kochibei* YABE et SHIMIZU	loc. 101
11.	*Leopoldia* (?) sp.	loc. 101
12.	*Kabylites* (?) sp.	loc. 203
13.	*Crioceratites* (?) sp.	loc. 101
14.	*Hoplocrioceras* (?) sp.	loc. 101
15.	Cf. *Hoplocrioceras remondi* (GABB)	loc. 100
16.	*Acrioceras* aff. *tabarelli* (ASTIER)	loc. 203
17.	*Acrioceras* (?) sp.	loc. 203
18.	*Lytocrioceras* (?) aff. *furcatum* (D'ORBIGNY)	loc. 203
19.	*Lytocrioceras* (?) sp.	loc. 203
20.	*Lytocrioceras* (?) or *Heteroceras* (?) sp.	loc. 203
21.	Ancyloceratid gen. et sp. indet.	loc. 3111
22.	Ancyloceratid (?) gen. et sp. indet.	loc. 203
23.	*Ancyloceratid or Turrilitid gen. et sp. indet.	loc. 203
24.	*Hamiticeras* (?) sp.	loc. 203
25.	**Heteroceras* (*H.*) aff. *astieri* D'ORBIGNY	locs. 203, 307
26.	*Heteroceras* sp.	loc. 203
27.	**Heteroceras* (?) sp.	loc. 203
28.	*Anahamulina* aff. *subcylindrica* (D'ORBIGNY)	loc. 203
29.	*Anahamulina* (?) sp.	loc. 203
30.	*Cymatoceras* aff. *neocomiense* (D'ORBIGNY)	loc. 203

* abundant species

aff. *strettostoma*, from the upper part of the Ishido Formation have been described. They are associated with several other species. The species related to the described two occur characteristically in the lower zone of the Upper Barremian in the Caucasus region as well as in Europe and other parts of the world. Some ammonites from the lower part of the Ishido Formation suggest the lower Lower Barremian to Upper Hauterivian. Thus, when correlated with the international reference scale on the basis of the fossil evidence, the Ishido Formation is supposed to range from lower Upper Barremian to Upper Hauterivian.

In the Japanese Islands, *Heteroceras* aff. *astieri* and *Barremites* aff. *strettostoma* were reported also from the uppermost member of the Arida Formation of the Kii Peninsula, in association with *Barremites* spp. and ancyloceratid (OBATA and OGAWA, 1976). *Crioceratites* (*Emericiceras*) cf. *emerici* was reported from the Isejigaura

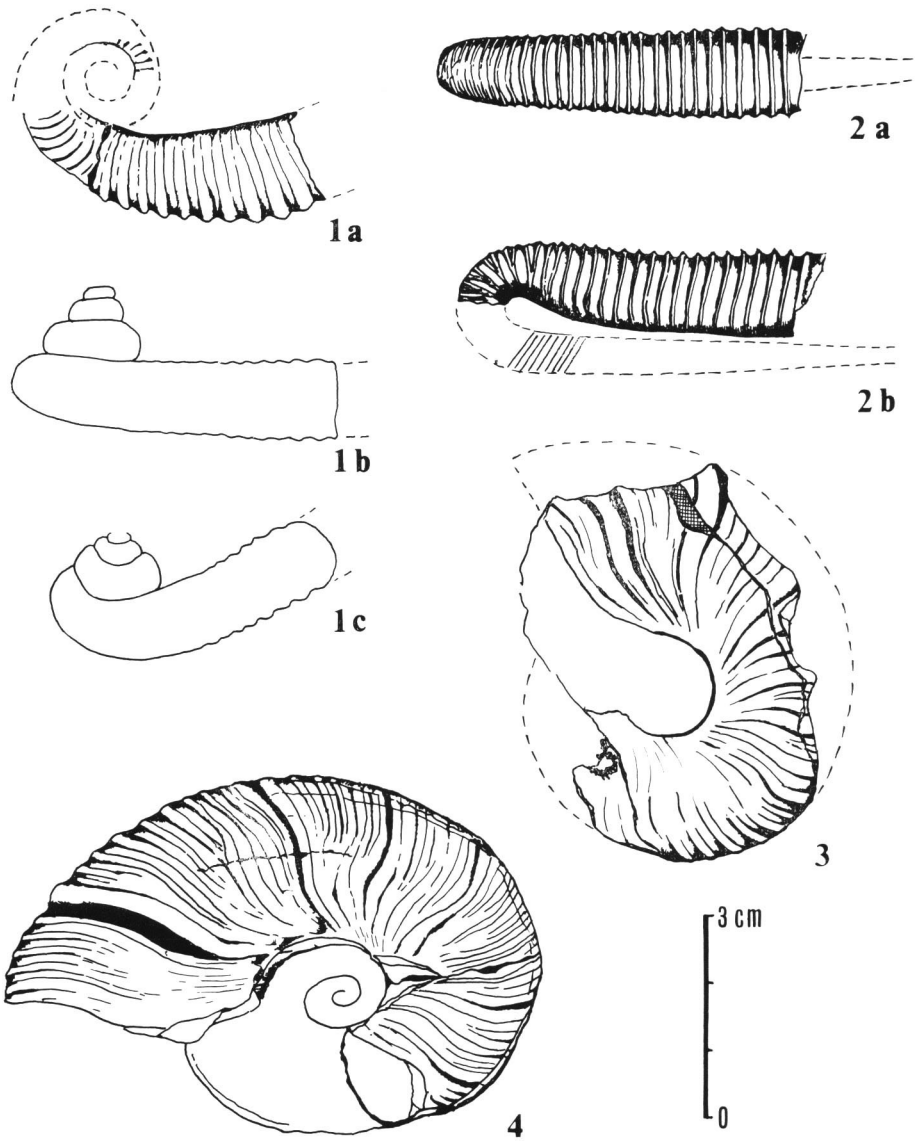


Fig. 6. Restored figures of some ammonites.

1. *Heteroceras* sp.
NSM-PM 7299 from loc. 203. Apical (a), lateral (b) and ventrolateral (c) views.
2. *Anahamulina* aff. *subcylindrica* (D'ORBIGNY)
NSM-PM 7294 from loc. 203. Ventral (a) and lateral (b) views.
3. *Pseudohaploceras* (?) *otsukai* (YABE et SHIMIZU)
NSM-PM 7296 from loc. 203. Lateral view.
4. *Barremites* (*B.*) (?) aff. *difficilis* (D'ORBIGNY)
NSM-PM 7294 from loc. 202. Lateral view.

Formation, the lowermost member of the Cretaceous deposits of the Choshi area, in association with *Holcodiscus* sp., *Barremites* spp., etc. (OBATA et al., 1975).

In short, the upper part of the Ishido Formation is safely correlated with the uppermost part of the Arida Formation, Kii Peninsula. The lower part of the Ishido Formation is probably correlated with the Isejigaura Formation, Choshi. It is evident that the Barremian species of Desmoceratacеae, Ancyloceratacеae and Turrilitaceae were distributed not only in the Meditteranean region and along the west coasts of North and South America but also in the western Pacific region during that period.

References

ARAI, J. and Y. NAGANUMA, 1975. Sedimentological studies on the Cretaceous formation in the eastern part of the Sanchu Graben, Saitama Prefecture, central Japan. *Mem. Saitama Univ.*, **23**: 17–32. [In Japanese with English abstract.]

BUSNARDO, R., 1965. Le stratotype du Barrémien, I—Lithologie et macrofaune. *In*: Colloque sur le Crétacé inférieur (Lyon, septembre 1963). *Mém. B.R.G.M.*, (34): 101–116.

DIMITROVA, N., 1967. Les fossiles de Bulgarie, IV. Crétacé inférieur. Céphalopoda (Nautiloidea et Ammonoidea). 424 pp. (incl. 93 pls.), Sofia, Acad. Bulg. Sci. [In Bulgarian with French abstract.]

EGUCHI, M., 1951. Mesozoic hexacorals of Japan. *Sci. Rep. Tohoku Univ., 2nd. Ser.*, **24**: 1–96, pl. 28.

ERISTAVI, M. S. and A. G. KHALILOV, 1961. Subdivision stratigraphique du Crétacé inférieur du Caucase. *Ann. Inst. géol. publ. hungar.* (Matér. conf. Mésozoique), **19**(3): 831 pp.

FUJIMOTO, H., K. WATANABE, S. AKAGI and H. IIJIMA, 1957. On the geology of the northwestern marginal district of the Kwanto Massif. *Bull. Chichibu Sci. Mus.*, (7): 17–28. [In Japanese with English abstract.]

HARADA, T., 1890. Die japanischen Inseln, eine topographisch-geologische übersicht. 126 pp., Paul Parey, Berlin.

HAYAMI, I., 1965–66. Lower Cretaceous marine pelecypods of Japan, Part 1. *Mem. Fac. Sci. Kyushu Univ., ser. D*, **15**: 221–350, pls. 27–52 (1965); Part 2–3. *Ibid.*, **17**: 73–150, pls. 7–21; 151–249, pls. 22–26 (1966).

HAYAMI, I. and T. ICHIKAWA, 1965. Occurrence of *Nippononaia ryosekiana* from the Sanchu area, Japan. *Trans. Proc. Palaeont. Soc. Japan, N.S.*, (60): 145–155, pl. 17.

HAYAMI, I. and I. NAKAI, 1965. On a Lower Cretaceous pelecypod, *"Cyrena" naumanni*, from Japan. *Ibid.*, (59): 114–125, pls. 13, 14.

HYATT, A., 1900. Cepahlopoda. *In*: ZITTEL-EASTMAN, Textbook of Palaeontology, 1st English ed., 1: 502–604, London.

IJIRI, S., 1938. Geologic structure of the so-called Sanchu Graben (Preliminary report). *Bull. Geol. Soc. Japan*, **45**(537): 475–477. [In Japanese.]

INOUE, M., 1974. Geologic structures of the Chichibu terrain in the Kanto Mountainous land, Japan. *Jour. Fac. Sci., Univ. Tokyo, Sec. II*, **19**(1): 1–25, pls. 1–3.

IWAI, S., 1947. Geology of the eastern part of the Santyu Graben. Appendix by R. SUGIYAMA: Note on geology of the western margin of the Santyu graben. *Bull. Tokyo Sci. Mus.*, (11): 1–21. [In Japanese.]

KARAKASCH, N., 1909. Le Crétacé inférieur de la Crimée et sa faune. *Trav. Soc. Imp. Nat. St. Petersbourg, Sec. Géol. Min.*, **32**(5): 1–482, pls. 1–28. [In Russian with French abstract.]

KEMPER, E., P. F. RAWSON, Fr. SCHMID and Chr. SPAETH, 1974. Die Megafauna der Kreide von

Helgoland und ihre biostratigraphische Deutung. *Newsl. Stratigr.*, **3**(2): 121–137, 2 tables.

KILIAN, W., 1907–13. *Unterkreide (Palaeocretacicum)*: *In*: FRECH, F., *Lethaea Geognostica*, II. Mesozoicum, Band **3** (Kreide), Lief. 1 (1907), 1–168; Lief. 2 (1910), 169–287, pls. 1–8; Lief. 3 (1913), 289–398, pls. 9–14.

KOBAYASHI, T. and the students of intermediate class, Univ. Tokyo, 1943. Geology of the several districts in the Kanto mountainous land. *Jour. Geol. Soc. Japan*, **50**: 229–241. [In Japanese.]

LUPPOV, N. P. and V. V. DRUSHCHITS, 1958. *In*: ORLOV, Y. A. [Editor], Fundamentals of Palaeontology, vol. VI, Mollusca—Cephalopoda II, 358 pp. including 71 pls. Acad. Sci. USSR. [In Russian.]

MEEK, F. B., 1876. A report on the invertebrate Cretaceous and Tertiary fossils of the upper Missouri Country: *In*: MEEK, F. B. and HAYDEN, F. V., *U.S. Geol. Geog. Surv. Terr., Mon.*, **9**; 8+xix+629 pp., 45 pls.

OBATA, I., S. HAGIWARA and S. KAMIKO, 1975. Geological age of the Cretaceous Choshi Group. *Bull. Natn. Sci. Mus., Ser. C*, **1**(1): 17–36, 5 pls. [In Japanese with English abstract.]

OBATA, I. and Y. OGAWA, 1976. Ammonites biostratigraphy of the Cretaceous Arida Formation, Wakayama Prefecture. *Ibid.*, **2**(2): 93–110, 4 pls. [In Japanese with English abstract.]

OISHI, S., 1940. The Mesozoic Floras of Japan. *Jour. Fac. Sci., Hokkaido Imp. Univ. Ser. 4*, **5**(2–4): 123–480, 48 pls.

OKUBO, M. and M. HORIGUCHI, 1969. Geological map of Japan and its explanatory text, Mamba sheet (1: 50,000). 66+6 pp. Geol. Surv. Japan. [In Japanese with English abstract.]

ORBIGNY, Alcide D', 1840–42. Paléontologie française. Terrains crétacés 1, Céphalopodes, 662 pp., 148 pls. [1–120 (1840); 121–430 (1841); 431–662 (1842)], Paris.

ORBIGNY, Alcide D', 1850. Prodrome de paléontologie stratigraphique universelle, Paris.

ORBIGNY, Alcide D', 1851. Notice sur le genre *Heteroceras* de la classe des Cépahlopodes. *J. Conch., Paris*, **2**: 217–222.

ROMAN, F., 1938. Les ammonites jurassiques et crétacées. 554 pp., 53 pls., Paris, Masson et Cie.

ROUCHADZÉ, J., 1933. Les ammonites aptiennes de la Géorgie occidentale. *Bull. Inst. géol. Géorgie*, **1**: 165–273, pls. 1–22.

SAKA, Y., 1974. Some current markings in the Cretaceous San-yama Formation of the Sanchu-graben, Saitama Prefecture, Japan (Part 1. Area of the Susuki River). *Sci. Rep. Educ. Waseda Univ., Ser. Biol. Geol.*, **23**: 9–26, 8 pls. [In Japanese.]

SHIMIZU, S., 1931. The marine Lower Cretaceous deposits of Japan, with special reference to the ammonites-bearing zones. *Sci. Rep. Tohoku Imp. Univ., Ser. 2*, **15**: 1–40, pls. 1–4.

SHIRAKURA, M., 1958. Geology of Saku Mountains. Geology of Nagano Prefecture, III, 72–93. [In Japanese.]

TAKEI, K., 1963. Stratigraphy and geological structure of the Cretaceous System in the eastern part of the Sanchu Graben, Kwanto Mountainland. *Jour. Geol. Soc. Japan*, **69**: 130–146. [In Japanese with English abstract.]

TAKEI, K., 1964. Geologic history of the Cretaceous System in the eastern part of the Sanchu Graben. *Bull. Chichibu Sci. Mus.*, (11): 1–21. [In Japanese with English abstract.]

TANAKA, K., 1965. Cretaceous echinoids from the Sanchu Graben, central Japan. *Trans. Proc. Palaeont. Soc. Japan, N.S.*, (59): 126–142, pls. 15–16.

TANAKA, K. and M. SHIBATA, 1961. A new species of *Aphelaster* from the Lower Cretaceous of Japan. *Ibid.*, (42): 68–72, pl. 10.

UHLIG, V., 1907. Die Cephalopodenfauna der Wernsdorfer Schichten. *Denkschr. K. Akad. Wiss., Wien, Math.-Nat. Kl.*, **46**: 127–290, pls. 1–32.

WRIGHT, C. W., 1955. Notes on Cretaceous ammonites; II, The phylogeny of the Desmoceratacae and the Hoplitaceae. *Ann. Mag. Nat. Hist., Ser. 12*, **8**: 561–575.

WRIGHT, C. W., 1957. *In*: MOORE, R. C. [Editor], Treatise on Invertebrate Paleontology, Part L, Mollusca, Cephalopoda, Ammonoidea, Ll-L490, Geol. Soc. Amer. & Univ. Kansas Press.

YABE, H., T. NAGAO, and S. SHIMIZU, 1926. Cretaceous mollusca from the Sanchu Graben in the Kanto Mountainland, Japan. *Sci. Rep. Tohoku Imp. Univ., 2nd Ser.*, **4**: 33–76, pls. 12–15.

YABE, H. and T. SUGIYAMA, 1930. Stromatoporoids and the related forms from the Jurassic of Japan. *Japan. Jour. Geol. Geogr.*, **8**: 23–28, 1 table.

YABE, Y., 1955. Geology of Agano-mura and its neighbourhood, Tano-gun, Gunma Prefecture. Geol. Soc. Japan, 1955 meeting, Explanatory book for the excursion. [In Japanese.]

YOKOYAMA, M., 1894. Mesozoic plants from Kozuke, Kii, Awa and Tosa. *Jour. Coll. Sci., Imp. Univ. Tokyo*, **7**(3): 201–231, 9 pls.

ZITTEL, K. A., 1895. Grundzüge der Paläontologie, (Paläozoologie). viii+972 pp., Munich and Leipzig.

Explanation of Plates

Plate 1

Fig. 1. *Barremites* (*B.*) aff. *strettostoma* (UHLIG).
NSM-PM 7283 from loc. 203 (M. MATSUKAWA Coll.). Lateral view, ×2.5.

Fig. 2. Ancyloceratid (?) gen. et sp. indet.
NSM-PM 7289 from loc. 202 (I. HAYAMI Coll.). Lateral view, ×1.5.

Fig. 3. *Lytocrioceras* (?) aff. *furatum* (D'ORBIGNY).
NSM-PM 7290 from loc. 203 (Y. NOMURA Coll.). Lateral view of plaster cast, ×1.

Fig. 4. *Heteroceras* (*H.*) aff. *astieri* D'ORBIGNY.
NSM-PM 7287 from loc. 307 (M. MATSUKAWA Coll.). Lateral (a) and apical (b) views, ×1.

Fig. 5. *Kabylites* (?) sp.
NSM-PM 7291 from loc. 203 (M. FUTAKAMI Coll.). Ventral view, ×1.5.

Fig. 6. Cf. *Hoplocrioceras remondi* (GABB).
NSM-PM 7292 from loc. 100 (M. MATSUKAWA Coll). Laterai view of internal mould, ×2.

Fig. 7. *Heteroceras* (*H.*) aff. *astieri* D'ORBIGNY.
NSM-PM 7288 from loc. 203 (H. TSUDA and M. FUTAKAMI Coll.). Lateral view of shaft, ×0.5.

Plate 2

Fig. 1. *Acrioceras* aff. *tabarelli* (ASTIER).
NSM-PM 7293 from loc. 203 (Y. OGAWA Coll.). Lateral view of plaster cast, ×1.5.

Fig. 2. *Anahamulina* aff. *subcylindrica* (D'ORBIGNY).
NSM-PM 7294 from loc. 203 (H. TSUDA and M. FUTAKAMI Coll.). Ventral (a), ×1 and lateral (b) ×0.8, views.

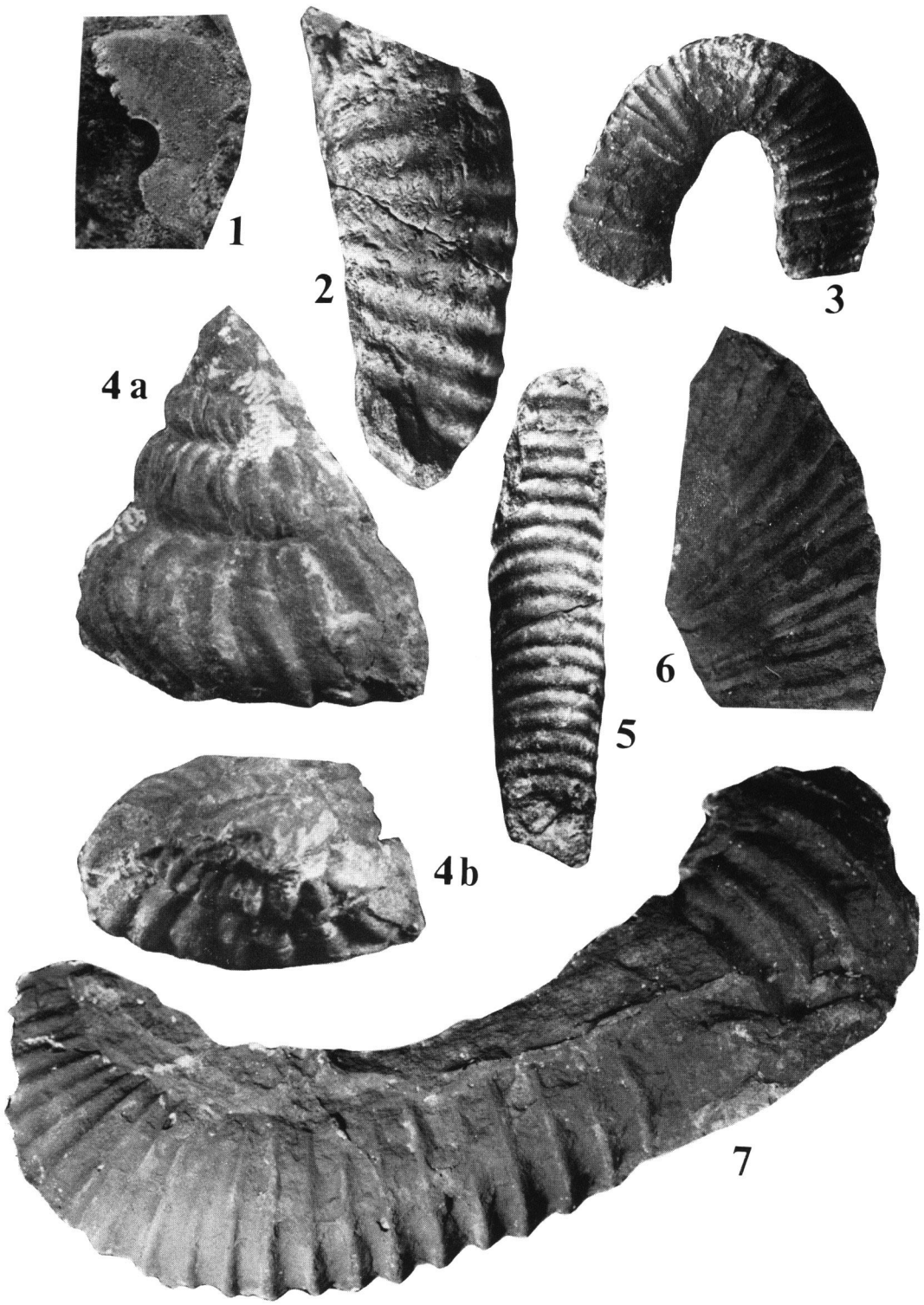
Fig. 3. *Barremites* (?) sp.
NSM-PM 7295 from loc. 307 (M. MATSUKAWA Coll.). Lateral view, ×1.5.

Fig. 4. *Barremites* (*B.*) aff. *strettostoma* (UHLIG).
NSM-PM 7281 from loc. 203 (H. TSUDA Coll.). Lateral view, ×1.5.

Fig. 5. *Pseudohaploceras* (?) *otsukai* (YABE et SHIMIZU).
NSM-PM 7296 from loc. 203 (M. FUTAKAMI Coll.). Lateral view, ×1.

Fig. 6. *Cymatoceras* aff. *neocomiense* (D'ORBIGNY).
NSM-PM 7298 from loc. 203 (Y. OGAWA Coll.). Lateral view, ×0.5.

Fig. 7. *Barremites* (*B.*) (?) aff. *difficilis* (D'ORBIGNY).
NSM-PM 7297 from loc. 202 (K. OGAI Coll.). Lateral view, ×1.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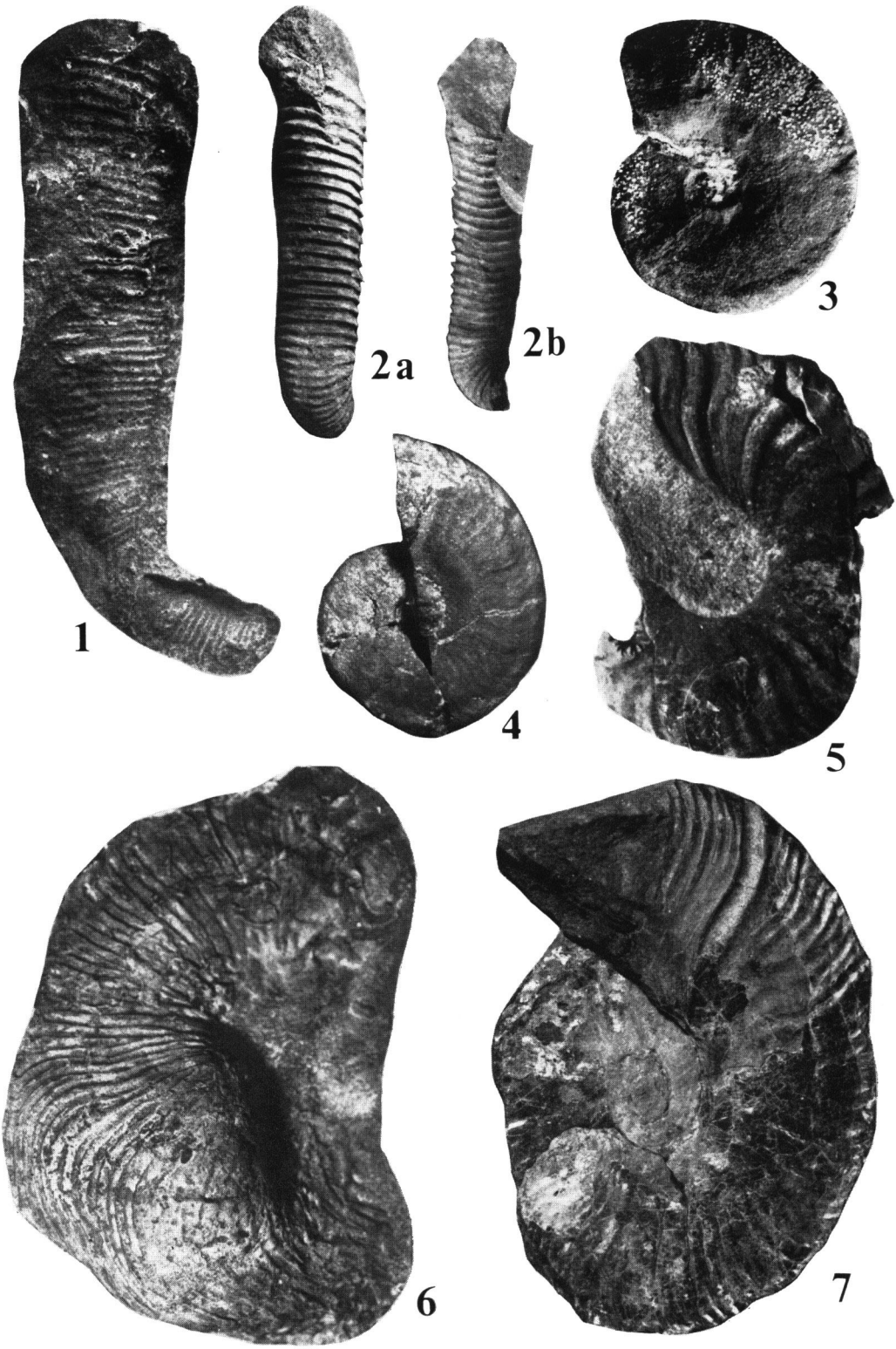
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