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SOME AMMONITES FROM THE CAMPANIAN (UPPER CRETACEOUS) OF NORTHERN HOKKAIDO

BY

Tatsuro MATSUMOTO

With Collaboration of Toshiya Miyauchi in Part II

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Abstract

The Upper Cretaceous strata characterized by the occurrence of an ammonite species *Metaplacenticeras subtilistriatum* (Jimbo) are exposed in the Teshio Mountains and the coastal area of Cape Soya, northern Hokkaido. The lithostratigraphic sequences and the modes of occurrence of fossils are, however, somewhat dissimilar between the two areas. In the former *M. subtilistriatum* occurs abundantly together with some other species in a limited part (dark coloured silty sandstone) but this fossiliferous zone is underlain by members of poorly or non-fossiliferous coarser sandstone and then by another member characterized by *Sphenoceramus schmidti* (Michael) – *Canadoceras kossmati* Matsumoto. In the Soya area the unit characterized by *M. subtilistriatum* is not so prolific as in Teshio but underlain by a member of fossiliferous silty sandstone in which *Schlueterella kawadai* sp. nov. occurs diagnostically among others and also *M. subtilistriatum* is occasionally found. The member with *S. kawadai* is underlain soon by another very fossiliferous member which can be assigned to the upper part of the Zone of *Sphenoc. schmidti-C. kossmati.*

In the main part of this paper the systematic descriptions of the ammonites from the above mentioned strata are given in two parts: – those from the Teshio Mountains in Part I by T. Matsumoto and those from the Soya area in Part II by T. Matsumoto & Miyauchi.

The described ammonite species are altogether 37, of which 11 new species of *Menuites, Pachydiscus, Canadoceras, Hoplitoplacenticeras, Saghalinites, Gaudryceras, Schlueterella* and *Parasolenoceras* and 1 new subspecies of *Baculites chicoensis* Trask have been established on the material from the studied strata. Some other species have been revised to a considerable extent, with discussions on relevant genera. A few are still left undescribed.

In conclusion, the Zone of *M. subtilistriatum* is defined and its subdivisions and underlying subzones are proposed tentatively. Comparing the studied ammonite sequences and certain characteristic species with those of the comparatively better studied areas in Europe and other regions, the Zone of *M. subtilistriatum* is referred to the lower part of the Upper Campanian. There is, however, considerable provincial dissimilarity between the contemporary faunas.

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SOME AMMONITES FROM THE CAMPANIAN (UPPER CRETACEOUS) OF NORTHERN HOKKAIDO

By

Tatsuro MATSUMOTO

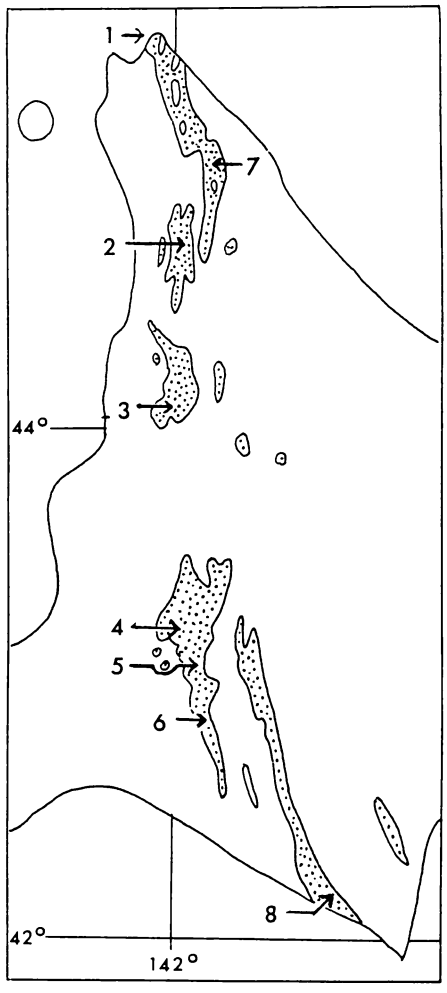
With Collaboration of Toshiya Miyauchi in Part II

INTRODUCTION

The main purpose of this paper is to give palaeontologic descriptions of the ammonites which have been recently obtained from the Campanian of northern Hokkaido. Speaking more precisely, the purpose of this study is to define the Zone of *Metaplacenticeras subtilistriatum* in the Upper Campanian and to describe the ammonites from this zone and also from the underlying parts.

I proposed and have revised the scheme of zonation by ammonoids and inoceramids for the Upper Cretaceous of Japan (e.g. Matsumoto, 1959d; 1977b; 1981 *in* Takayanagi & Matsumoto, 1981). Although the scheme is designed to be applied comprehensively to various areas in Japan, it is based on reference sequences in particular areas where fossiliferous strata are well exposed. For instance, the Ikushumbets and adjacent areas in central Hokkaido and the Obira area in northwestern Hokkaido display us fairly good biostratigraphic sequences for the stages from the Cenomanian to the Santonian (e.g., Matsumoto *et al.*, 1978 for 1976; Hirano *et al.*, 1977; Obata & Futakami, 1977; Tanabe *et al.*, 1977). For some geological reasons, the Campanian and the Maastrichtian are represented by generally more coarse-grained, deltaic sediments called the Hokobuchi Group in central Hokkaido and are mostly absent in the Obira and adjacent areas in northwestern Hokkaido because of the pre-Tertiary erosion. Beds of shallow sea facies with some ammonites and inoceramids are intercalated in the Hokobuchi Group of the Hobetsu-Hetonai (Hetonai=Tomiuchi in the modern place name) area in southern central Hokkaido. Hence the Hetonaian was proposed for the approximate correlative of the Campanian plus Maastrichtian in Japan (Matsumoto, 1942–1943).

More continuous and thicker marine sequences of the Hetonaian are shown in the Tombetsu Valley of northern Hokkaido. The biostratigraphy of this area was reported by Matsumoto *et al.* (1980, 1981, both written in Japanese) and a few ammonite species from there were described by Matsumoto (in Matsumoto *et al.*, 1979). The Cretaceous strata exposed in the Tombetsu area represent a comparatively offshore facies in the Cretaceous basin, called the Yezo geosyncline, being rich in microfossils, which were preliminarily studied by Maiya & Inoue (in Matsumoto *et al.*, 1981) and are now being studied by Yasuda (1984) and others, but poor in ornate ammonites which are useful for inter-regional correlation.



Text-fig. 1. Map of the main part of Hokkaido, showing the areas mentioned in the text. Dotted: post-Aptian Cretaceous outcrops. 1: Cape Soya, 2: northern Teshio Mountains (including Saku, Abeshinai and Embetsu (Wembets), 3: southern Teshio Mountains (incl. Haboro, Kotanbetsu and Obira), 4: Ikushumbets (Mikasa), 5: Oyubari, 6: Hobetsu-Hetonai (Tomiuchi), 7: Tombetsu, 8: Urakawa.

In contrast to the Cretaceous rocks of the Tombetsu area, those of the Teshio Mountains and the Cape Soya represent near shore facies in the Cretaceous basin. Here the Upper Campanian Zone of *Metaplacenticeras subtilistriatum* is typically displayed. There is, however, a drawback in that the overlying part of the Upper Cretaceous is almost lacking because of the pre-Miocene erosion and only a fraction of the Maastrichtian remains locally.

The geologic conditions are somewhat dissimilar between the two areas. In the Teshio Mountains the fossiliferous zone rich in *M. subtilistriatum* is underlain by a unit of cross-bedded coarse-grained sandstone which is poor in ammonites as in the main part of the Hokobuchi Group. In the Cape Soya area the *Metaplacenticeras* bearing beds do exist but are not so prolific as in the Teshio Mountains. It is underlain by a sequence of ammonite bearing beds. In other words the two areas are complementary with each other for us to study finer zonal sequences of the Campanian in northern Hokkaido.

The Urakawa area in southern Hokkaido, which belongs to the eastern subbelt of the Yezo geosyncline, is another place where the bed with *M. subtilistriatum* is exposed (Matsumoto, 1942; Kanie, 1982). Here again the succeeding beds do not follow this zone in the actual exposure and the Maastrichtian is isolatedly exposed in a faulted block.

The better biostratigraphic sequences which suceed to the Zone of *M. subtilistriatum* exist in the Izumi Group of Southwest Japan, as I have briefly mentioned with coworkers (Matsumoto *et al.*, 1980; Matsumoto *et al.*, 1981), and are under preparation to be published elsewhere.

Under the above circumstances, the observed facts of biostratigraphy in the Teshio Mountains and the Cape Soya are described in detail with special reference to the Zone of *M. subtilistriatum* and the underlaying parts and also the systematic descriptions of the ammonites therefrom are given in this paper.

As to the Cretaceous of the Cape Soya area (or briefly called the Soya area), T. Miyauchi,

a naturalist in Wakkanai, has been engaged for years in the field work as well as the preliminary sorting and cleaning of the obtained fossils. Therefore, this paper is subdivided into three parts with dissimilar authorships as follows:

Part I. Ammonites from the Upper Campanian of the Teshio Mountains ..... By T. Matsumoto

Part II. Some Campanian ammonites from the Soya area ..... By T. Matsumoto and T. Miyauchi

Part III. Concluding remarks ..... By T. Matsumoto

The repositories of the described specimens are mainly the Geological Collection, Kyushu University, Fukuoka (with abbreviation GK.) for Part I and the Natural History Collection of Northern Hokkaido, now kept by T. Miyauchi, Wakkanai (with abbr. MNH.) for Part II. The holotypes have been transferred from MNH. to GK. Some specimens are still in private collections whose proprietors will be recorded in each part. Some of older collections in the University Museum, University of Tokyo (UMUT.) may be also referred to.

To describe the dimensions of the specimens the following abbreviations are used in this paper:

D=diameter at a given growth-stage, U=diameter of umbilicus, H=height of whorl, B=breadth of whorl, ~=approximate.

Acknowledgements.—This work has been carried on partly at the Research Institution of the Seinangakuin University and partly at the Department of Geology, Kyushu University. Thanks are especially due to Professor Yoshifumi Karakida, Professor Kametoshi Kanmera and Professor Tsugio Shuto for fascilities provided for me to study there.

I thank many friends who kindly helped me in the field work in the Teshio Mountains and donated some of their collections to Kyushu University or let me borrow some other specimens for this study. They are Messrs. Tatsuo Muramoto, Kikuwo Muramoto, Takemi Takahashi, Kenji Sanada, Haruhiro Kokubu, Minoru Yamashita, Toshio Shimanuki, Akio Tomita, Yoshitaro Kawashita, Mitsutoshi Nihongi, Takaharu Nishino and Yasunori Nakaya. For the study of the Soya area I owe much to Mr. Toshiya Miyauchi, who joined with me as a coauthor. Miyauchi and I are grateful for the kind help in various ways by Messrs. Hajime Honma, Toshio Saheki, Terumasa Masuda, Seiji Hayama and Kinji Takagaki and also for the warm support by Mr. Akio Tanabe and Mr. Eiji Nagai, member of the Board of Education, Wakkanai City.

Thanks are extended to Dr. Masayuki Noda, who kindly photographed the selected specimens with his export technique, Dr. Ikuwo Obata, who read carefully the manuscript, Dr. I. Hayami, who gave me facilities for access of UMUT specimens, and Miss Kazuko Hara and Miss Yoshimi Tanigawa who assisted me in preparing the typescript.

It should be recorded with gratitude that this paper is a part of the results of a major project "International Correlation of the Cretaceous System in Japan" which was financially supported by the Science Funds (No. 334043) of the Ministry of Education, Science and Culture. We owe much to Professor Tsugio Shuto, Editor, in setting forth the manuscript into the Palaeontological Society of Japan Special Papers No. 27.

PART I. AMMONITES FROM THE UPPER CAMPANIAN OF THE TESHIO MOUNTAINS

By

T. MATSUMOTO

(Studies of the Cretaceous Ammonites from Hokkaido – L)

Notes on Stratigraphy

The Teshio Mountains occupy the northwestern part of Hokkaido, extending from north to south for about 140 km. The ammonites which I am going to describe in Part 1 are from the northern half of the Teshio Mountains. The main part of the area is made up of the Cretaceous System, which consists of the Sorachi Group, the Lower Yezo Group, the Middle Yezo Group, the Upper Yezo Group and the Hakobuchi Group in ascending order. The Tertiary is distributed mainly in the lower hilly part of the area, overlying the Cretaceous strata with an unconformity of a considerable time gap.

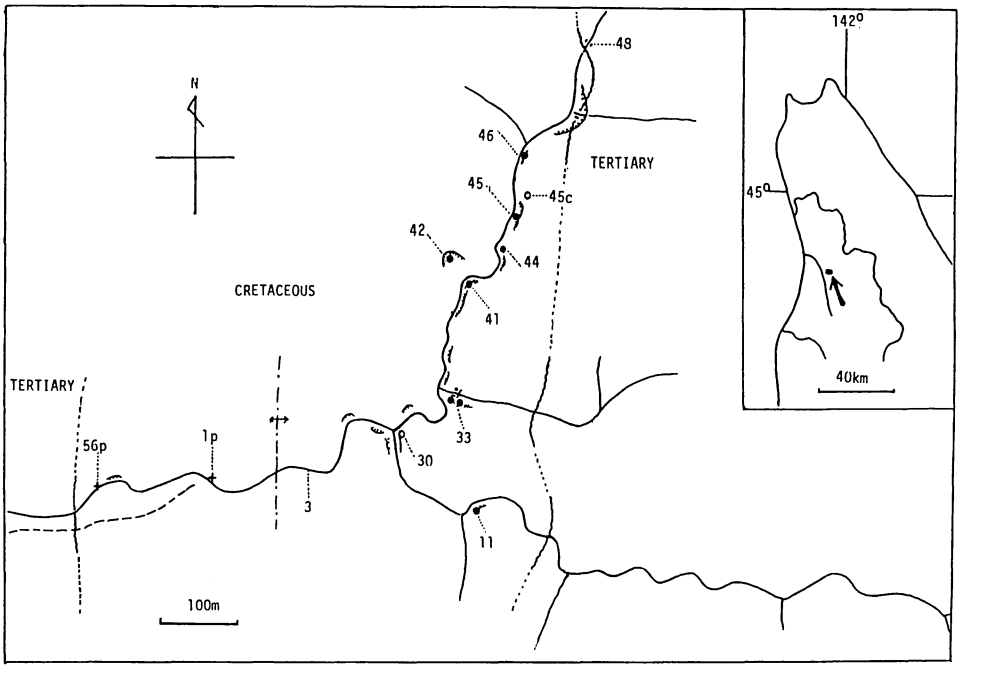
Apart from the eastern marginal part of the area with complicated geologic structure, the formations are generally arranged from east to west in ascending order, although there may be repetition or omission and displacement of strata by minor folds and faults. The Hakobuchi Group is distributed very narrowly along the divide between the River Abeshinai (a tributary of the River Teshio) on the east and the River Embetsu (=Wembets) on the west. This topographic divide coincides with the administrative boundary between Nakagawa-gun and Teshio-gun (gun: administrative unit which corresponds approximately to a county).

Now, in the Cretaceous of Hokkaido, a boundary of litho-stratigraphic units may be diachronous in some cases. For example, the type Hakobuchi Group of the Mikasa-Oyubari-Hobetsu area in central Hokkaido, which consists of sandstone, conglomerate and sandy siltstone of shallow water facies, is Campanian and Maastrichtian in age and the underlying Upper Yezo Group in the same area, which is made up predominantly of ammonite rich mudstone with several beds of sandstone, is Coniacian and Santonian. As I have already explained (Matsumoto, 1942–43; 1954a, 1959d), the Upper Yezo Group in the Teshio Mountains ranges in age from Coniacian to Lower Campanian and the overlying Hokobuchi Group is mainly Upper Campanian. Because of this discrepancy in age and also the difference in the details of lithofacies, Takahashi (1959) proposed the Yasukawa Group for the so-called Hakobuchi in the Teshio Mountains. This name can be used locally. The upper part of the Upper Yezo Group in the Teshio Mountains, which I marked as IIIc, IIId and IIIe, is locally called the Osoushinai Formation by the authors of the explanatory texts of the official geological maps (Osanai *et al.*, 1960; Hata, 1961; Nagao, 1962; Hashimoto *et al.*, 1967; Hata & Tsushima, 1969). Incidentally, the Maastrichtian part of the Hakobuchi Group seems to have been mostly eroded away before the deposition of the Tertiary formations in the Teshio Mountains, except for a fraction of it remaining at certain places.

Biostratigraphically, as was reported years ago (Matsumoto, 1942–43) and confirmed by subsequent authors (Takahashi, 1959; Hashimoto *et al.*, 1967; etc.), the highest fossiliferous part of the Upper Yezo Group in the Teshio Mountains is represented by the Zone of *Sphenoceramus schmidti-Canadoceras kossmati*. Takahashi (1959) recognized a member of bioturbated muddy sandstone (called the *dorokui shagan* in Japanese) above the *Schmidti* Zone and discussed that this top member of the Upper Yezo Group is overlain by the Yasukawa Group with an unconformity. His observations have not been clearly confirmed by subsequent authors (e.g. Hashimoto *et al.*, 1967). In my opinion, the bioturbated muddy sandstone is a unit of a particular facies which may occur at dissimilar stratigraphic levels between separate places, e.g. between the area of the divide and the upper reaches of the Abeshinai in the southeast. The uneven surface at the bottom of the pebbly sandstone of the Yasukawa Group may be a sedimentary feature which occurs frequently in the deposition of shallow water coarse-grained sediments. Anyhow, the unconformity in this case, if present, does not imply a significant time gap.

In the middle part of the Yasukawa Group the sandstone is dark coloured and muddy, containing calcareous nodules in which *Metaplacenticeras subtilistriatum* occurs fairly commonly along with some other ammonites. The exposures in the tributaries of the River Abeshinai on the east side of the divide have become unfavourable for collecting fossils. Those in the upper reaches of the River Uttsu and in the Wembets-Rubeshbe (=Embetsu-Rubeshibe), a tributary of the River Embetsu on the west side of the divide are still suitable for our study.

The ammonites described in Part 1 are mostly from this west side area and partly from



Text-fig. 2. Route map along the Wembets-Rubeshbe in the Teshio Mountains. • Localities of *Metaplacenticeras subtilistriatum* and associated species. ○ Locality of other species, without *M. subtilistriatum*, + Locality where fossils were obtained from fallen or floated nodule. Every locality has a prefix E on the indicated number.

the east. Especially, the Wembets-Rubeshbe is the classical area where the type locality of "*Placenticeras*" *subtilistriatum* Jimbo, 1894 is situated. In this place Upper Cretaceous strata crop out in the Tertiary area, forming a narrow belt, as has been revealed by an official mapping (Hata & Tsushima, 1969). The results of my study on the details of the stratigraphic sequence exposed along this stream have recently been reported concisely (Matsumoto, 1982b). Text-figs. 2 and 3 are reproduced from that report.

The narrow Cretaceous belt, about 650 m in breadth, is a core of an anticline. The sequence is better exposed on the eastern wing of this anticline, showing the following succession in ascending order (see also Text-fig. 3):

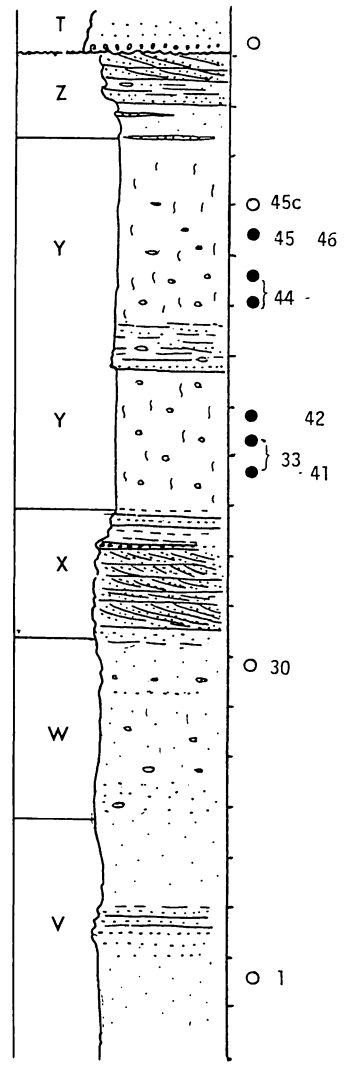
V. Coarse- to medium grained sandstone, generally massive and partly bedded, intercalating a thin coaly seem at the bedded part, about 50 m in thickness. Fossils very rare, except for *Canadoceras* cf. *C. kossmati* Matsumoto at loc. E1p, below the bedded sandstone.

W. Massive sandstone, more or less silty, sometimes containing calcareous nodules, about 35 m. Fossils rare, but for a large fragmentary shaft of *Schlueterella* sp. at loc. E30 in the upper part.

X. Coarse- to medium-grained sandstone, cross-bedded, with an intercalated lenticular bed of conglomerate, 25 m. Fossils not yet found, but for fragmentary wood.

Y. Massive, dark coloured, silty sandstone or sandy siltstone, containing calcareous nodules, in which *Metaplacenticeras subtilistriatum* occurs abundantly along with some other ammonites, gastropods, bivalves, scaphopods, brachiopods, simple corals and fish scales. This unit is about 75 m in thickness and the sandstone is partly bedded in its middle part. Numerous fossil localities are included in this unit, of which E 11, E 33, E 41 and E 42 are in its lower part and E 44, E 45, E 46 are in its upper part. I have not seen *M. subtilistriatum* in the uppermost part, about 20 m, of this unit. Therefore, the prolific part of *M. subtilistriatum* is about 55 m in thickness. The nodules and the surrounding matrix often contain drifted minute pieces of wood and other vegetable substance.

Z. Medium- to coarse-grained sandstone, cross-bedded, about 20 m. Fossils not found.



Text-fig. 3. Stratigraphic sequence of the Upper Cretaceous exposed along the stream of the Wembets-Rubeshbe on the eastern wing of an anticline. Marks of fossil localities as for those in Text-fig. 2. T: Tertiary, V-Z: Member of the Cretaceous sequence as described in the text. Scale: 10 m for each.

The last unit is overlain by the basal conglomerate of the Tertiary Chikubetsu Formation with a distinct unconformity. Some fragmentary ammonites (*Anapachydiscus* sp. etc.) are embedded in this conglomerate along with Miocene mollusca. The ammonites are undoubtedly derived fossils.

It should be noted that the members X to Z represent a cycle of sedimentation and that the Member Y, the prolific part of *M. subtilistriatum*, corresponds to the inundation phase. As a whole, however, the sediments of the Hakobuchi Group of the Teshio Mountains are of near-shore shallow sea environments.

The *M. subtilistriatum* bearing beds exposed along the upper reaches of the Uttsu are on the northern extension of thoee in the Wembets-Rubeshbe. The exposures are discontinuous along the Uttsu. The prolific part of the Zone of *M. subtilistriatum* is exposed at loc. T 5009, T 5010 and T 5011 in ascending order for about 30 m in thickness. It is certainly referred to a part of the Member Y in the section of the Wembets-Rubeshbe. Being interrupted for some distance of no exposure, there is a unit of silty fine-grained sandstone referable to X and below it there is a unit of silty fine-grained sandstone in which several pachydiscid ammonites (including an undeterminable huge one) and *Tetragonites popetensis* Yabe are embedded (loc. T 5016). Otherwise, this unit is poor in fossils. It is probably referable to the Member W of the Wembets-Rubeshbe. Regretably I have to omit to show the route map along the Uttsu to protect the fossil localities from too rough hunting by non-scientific persons.

Systematic Descriptions

Subclass Ammonoidea Zittel, 1884
Order Ammonitida Agassiz, 1847
Suborder Phylloceratina Arkell, 1950
Family Phylloceratidae Zittel, 1884
Genus *Neophylloceras* Shimizu, 1934

Type species:–Ammonites (*Scaphites*?) *ramosus* Meek, 1858

Remarks–Neophylloceras was established by Shimizu (1934, p. 61 *in* Shimizu & Obata) in a paper written in Japanese. Wright & Matsumoto (1954, p. 108) acknowledged that it is valied and translated Shimizu's writing into English.

Neophylloceras is indeed similar to *Phylloceras* Suess, 1865, with the type-species *Ammonites heterophyllus* J. Sowerby, 1820, in the shell-form, the lirae on the shell surface and also in the fundamental pattern of suture, but the distinction between the two genera in the partition of saddles, the degree of incisions and the narrowness of the stems of elements is clear, as Shimizu has already pointed out.

I can also distinguish *Neophylloceras* from *Hypophylloceras* Salfeld, 1924 (with the type-species *Phylloceras onoense* Stanton, 1895), as I have already discussed (Matsumoto, 1959a, p. 56).

The presence of some "intermediate form", if any, would not be the objection against the separation. I do not favour the suppression of *Neophylloceras* as a synonym of *Hypophylloceras*, taken by Wiedmann (1962, p. 257) and followed by Kennedy & Klinger (1977a). I do appreciate Wiedmann's result that *Hypophylloceras* is a direct descendant of *Phylloceras*. Likewise, *Neophylloceras* is a direct descendant of *Hypophylloceras*. Birkelund (1965, p. 21) wisely treated *Neophylloceras* as a subgenus of *Hypophylloceras*. Should *Hypophylloceras*

be treated as a subgenus of *Phylloceras*, then *Neophylloceras* would be another subgenus of *Phylloceras*.

I am afraid that some authors apt to disregard the precise pattern of sutures, but the degree of sutural incisions at corresponding growth stage can be evaluated as a criterion. Taking examples in the Pachydiscidae, *Eupachydiscus* is fairly similar to *Lewesiceras* in many respects as *Canadoceras* is so to *Nowakites*, but the suture is much more finely and deeply incised with narrower stems of elements in the former than in the latter. *Tongoboryoceras* Housa, 1967 may represent the intermediate state in this respect.

Besides *N. ramosum*, the following species are clearly referred to *Neophylloceras*: *N. subramosum* Spath, *N. hetonaiense* Matsumoto, *N. marshalli* (Shimizu), *N. radiatum* (Marshall), *N. nera* (Forbes), *N. surya* (Forbes), *N. woodsi* (van Hoepen), *N. bererensis* (Collignon), *N. tessonnierei* (Collignon), *N. mikobokense* (Collignon) and *N. groenlandicum* (Birkelund). They are all Late Cretaceous in age and mainly distributed in the seas facing the Cretaceous Pacific Ocean and the East Tethys, except for the last species. What has been called *P. serresitense* Pervinquière needs reexamination.

Neophylloceras is thus taxonomically distinguishable and biostratigraphically convenient. Merely for the sake of brevity, it is treated as a genus in this paper, although I have no objection against its subgenic ranking *Phylloceras* (*Neophylloceras*). I am not, however, favourable for the too frequent use of quadri-nominal taxa, for instance *Phylloceras* (*Hypophylloceras*) *velledae velledae* (Michelin, 1834). The subspecific separation of the forms in the strata of the same age within the same province would be biologically meaningless.

Neophylloceras ramosum (Meek, 1858)

Pl. 1, Fig. 1

1858. *Ammonites* (*Scaphites*?) *ramosus* Meek, *Trans. Albany Inst.*, vol. 4, p. 45.
1876. *Phylloceras*? *ramosum* Meek; Meek, *Bull. U. S. Geol. Geogr. Surv. Terr.*, vol. 2, no. 4, p. 371, pl. 5, figs. 1, 1a, 1b.
1942. *Neophylloceras ramosum* (Meek); Matsumoto, *Proc. Imp. Acad. Japan*, vol. 18, p. 674, text-figs. $1a_2$, b_2.
1952. *Neophylloceras ramosum* (Meek); Usher, *Geol. Surv. Canada Bull.* 21, p. 49, pl. 1, figs. 4, 5.
1959. *Neophylloceras ramosum* (Meek); Matsumoto, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, spec. vol. 1, pt. 2, p. 1, pl. 1, fig. 1; pl. 2, fig. 2; pl. 8, fig. 1 (with full list of synonymy).
1963. *Neophylloceras ramosum* (Meek); Jones, *U. S. Geol. Surv. Prof. Paper* 432, p. 22, pl. 6, figs. 1–8; text-fig. 7.

Material:–GK. H5942, phragmocone for the most part with a portion of the body-chamber.

Dimensions:–

Specimen	D	U	H	B	B/H
GK. H5942	85.0	6.0 (.07)	51.5 (.60)	25.8 (.30)	0.50
Holotype	39.2	3.2 (.08)	22.3 (.57)	11.7 (.30)	0.52

Remarks:–The specimen shows very well the diagnostic characters of *N. ramosum* (see Matsumoto, 1959c, p. 2 for the diagnosis).

Occurrence:–Loc. E33, Wembets-Rubeshbe, Teshio province, with *Metaplacenticeras subtilistriatum*. Two other examples (YN. 7 and YN. 15), though incompletely preserved, are in Y. Nakaya's Collection from loc. T5011, Uttsu in the same zone.

Neophylloceras cf. *N. nera* (Forbes, 1846)

Pl. 1, Fig. 3

Compare:–

1846. *Ammonites nera* Forbes, *Trans. Geol. Soc. London*, 2 ser., vol. 7, p. 106, pl. 8, fig. 7.
1895. *Phylloceras nera* (Forbes); Kossmat, *Beitr. Palaeont. Geol. Oesterr.-Ungarns*, vol. 9, p. 109, 160, pl. 16, fig. 2a–d.

Material:–GK. H5943, wholly septate specimen.

Dimensions:–

Specimen	D	U	H	B	B/H
GK. H5943	33.0	2.4 (.07)	19.2 (.58)	9.2 (.28)	0.48
Kossmat, 1895	20	1.5 (.08)	12 (.6)	6 (.3)	0.5
N. marshalli	42.0	5.5 (.13)	22.0 (.52)	12.0 (.28)	0.55

Description:–The shell is discoidal, compressed and much involute, with a very narrow umbilicus. The whorl is much higher than broad, with B/H = 0.48 at its preserved end, having flat falnks which are nearly parallel in the late growth-stage but slightly divergent in earlier stages with the maximum whorl-breadth at about the ventrolateral shoulder; the venter is narrowly rounded. Umbilical shoulder abruptly rounded, passing to a fairly inclined umbilical wall.

The shell surface is ornamented with numerous, dense, fine radial lirae, which are inclined forward around the umbilicus with a gently concave curvature and then gradually becoming nearly radial somewhat below the mid-flank. There are several radial furrows accompanied with indistinct bullae around the umbilicus, with several lirae coalescing into each bulla.

The suture is deeply and finely incised, with the folioles already subdivided at this small size.

Comparison:–The described characters conform very well the diagnosis of *N. nera* redescribed by Kossmat (1895). Although GK. H5943 is larger than the holotype, it is still small. The size and other characters of the full-grown shell are unknown. Despite this uncertainty, this specimen can be identified at least provisionally to *N. nera*.

Phylloceras nera of Marshall (1926, p. 134, pl. 19, fig. 4; pl. 26, figs. 1, 2), from New Zealand, was considered by Shimizu (1936b, p. 180) as distinct from *N. nera* but he did not give clearly the criteria. The specific name *N. marshalli* (Shimizu, 1935 *non. nud*) has become valid since Henderson, 1970 (p. 3, pl. 1, fig. 1).

GK. H5943 resembles the holotype of *N. marshalli* Henderson in having the flat and parallel flanks in the late growth-stage but the umbilicus of the former is distinctly narrower than that of the latter. Henderson compared carefully *N. marshalli* with *N. nera, N. woodsi* (van Hoepen, 1921) and *N. hetonaiense* Matsumoto, 1942, and noticed some differences in the suspensive lobes of suture. In GK. H5943 the auxiliary elements are aligned in a straightly descending line in a young stage but in an adorally slightly concave curve in a late growth-stage. In GK. H5943 the radial bullae around the umbilicus are very faint in the young stage, becoming somewhat more distinct later, although they are not so pronounced as in the holotype of *N. marshalli*.

To conclude the identity or distinction between *N. nera* and *N. marshalli*, we need more

specimens showing various growth-stages from both southern India and New Zealand.

Phylloceras nera of Paulcke (1907, p. 3, pl. 14, figs. 5, 5a–c), from Patagonia, may be rather closer to or possibly identical with *N. woodsi*, although the relationship between *N. nera* and *N. woodsi* should be likewise examined.

N. hetonaiense Matsumoto (see below) has gently convex flanks, with the maximum whorl-breadth at the mid-flank, and clearly distinguished from *N. nera* even in a young stage.

Occurrence:–Loc. E33, Wembets-Rubeshbe, Teshio provence. This is a rare occurrence.

Neophylloceras hetonaiense Matsumoto, 1942

Pl. 1, Figs. 4–5

1942. *Neophylloceras hetonaiense* Matsumoto, *Proc. Imp. Acad. Japan*, vol. 18, p. 675, text-figs. $1a_3$, b_3.
?1952. *Neophylloceras lambertense* Usher, *Geol. Surv. Canada Bull.* 21, p. 50, pl. 1, figs. 1–3.
1953. *Neophylloceras hetonaiense* Matsumoto; Spath, *Falkland Islands Dependencies Survey Sci. Rept.* no. 3, p. 5, pl. 1, fig. 2.
1959. *Neophylloceras hetonaiense* Matsumoto; Matsumoto, *Mem. Fac. Sci., Kyushu Univ.* ser. D, Spec. vol. 1, p. 5, pl. 3, fig. 1.
1963. *Neophylloceras hetonaiense* Matsumoto; Jones, U.S. *Geol. Surv. Prof. Paper* 432, p. 23, pl. 6, figs. i, 10; pl. 7, figs. 1–5; text-fig. 12.

Material:–GK. H5955, collected and then donated to GK. by A. Tomita, together with *Metaplacenticeras subtilistriatum* (GK. H5954 a-3) from the Wembets-Rubeshbe; GK. H5957, collected and then donated to GK. by T. Muramoto, together with *M. subtilistriatum* from the Abeshinai Rubeshibetsu, Teshio Mountains.

Dimensions:–

Specimen	D	U	H	B	G/H
GK. H5955	28.8	2.0 (.07)	16.0 (.55)	9.0 (.31)	0.56
GK. H5957	12.5	1.2 (.09)	7.4 (.59)	5.0 (.40)	0.67
Lectotype	31.0	2.0 (.06)	17.5 (.56)	10.0 (.32)	0.57

Descriptive remarks:–The two specimens are undoubtedly assigned to *N. hetonaiense* in showing the diagnostic features, such as great involution, very narrow umbilicus, much compressed whorls with the maximum breadth at the middle of the gently convex flanks, nearly radial lirae on the main part of flank with a gentle flexuosity on the lower part, and development of umbilical bullae in young stages. The density of lirae is moderate, numering about 40 in the whorl angle of 45°.

The suture is of typical *Neophylloceras* type, with subdivided terminals of folioles even in a young stage as small as 10 mm in diameter. The auxiliary elements are aligned on a slightly concave descending line.

It is noted that no significant difference is observed between the specimens here described and the lectotype and other syntypes from Unit IV b (probably Lower Maastrichtian) of the Hetonai (at present called Tomiuchi) area (southern central Hokkaido).

Based on the variation observed on the specimens from Alaska, Jones (1963, p. 24) regarded *N. lambertense* Usher, 1952 as a probable synonym of *N. hetonaiense*. This may be right, but I have not yet seen an example which shows as weak flexuosity of lirae as *N. lambertense* in the available specimens from Hokkaido. The similarity between the nominal two

species is so significant that they may be of identical species. We need more specimens from the Nanaimo Group to lead a definite conclusion.

Occurrence:–Rarely found in the Zone of *Metaplacenticeras subtilistriatum* in the Wembets-Rubeshbe and the Abeshinai-Rubeshibetsu of the Teshio Mountains.

Suborder Ammonitina Hyatt, 1867
Superfamily Desmoceratacеae Zittel, 1895
Family Desmoceratidae Zittel, 1895
Genus *Desmophyllites* Spath, 1929

Type species:–*Desmoceras larteti* Seunes, 1891 (subsequent designation for *Schlüteria*, Grossouvre, 1894 (non Fritsch & Kaffka, 1887), which was renamed as *Desmophyllites*).

Remarks:–See Matsumoto & Obata, 1955 (p. 119) for the general account of this genus.

Desmophyllites diphylloides (Forbes, 1846)
Pl. 1, Fig. 2

1846. *Ammonites diphylloides* Forbes, *Trans. Geol. Soc. London*, ser. 2, vol. 7, p. 105, pl. 8, fig. 8a, b, c.
1953. *Desmophyllites diphylloides* (Forbes); Spath, *Falkland Isl. Dependencies Survey, Sci. Rept.* no. 3, p. 21 (footnote), pl. 2, figs. 5, 6.
1955. *Desmophyllites diphylloides* (Forbes); Matsumoto & Obata, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 5, no. 3, p. 121, pl. 24, figs. 1–5; pl. 30, fig. 1; text-fig. 1.
1959. *Desmophyllites diphylloides* (Forbes); Matsumoto, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, spec. vol. 1, p. 9, pl. 3, fig. 3; text-fig. 2 (with full list of synonymy).

Material:–GK. H5962 (Pl. 1, Fig. 2) and GK. H5963 collected by A. Tomita from the Wembets-Rubeshbe; serveral others from the Uttsu and the Abeshinai-Rubeshibetsu.

Dimensions:–

Specimen	D	U	H	B	B/H
GK. H5962	27.0 (1)	1.8 (.07)	19.8 (.58)	12.5 (.46)	0.79
GK. H5963	36.0 (1)	2.5 (.07)	20.7 (.57)	19.0 (.47)	0.82

Descriptive remarks:–The specimens show well the characteristics of this species which are described by Matsumoto & Obata (1955). They are rather small and have the last septum at D = 21 mm or H = 12.5 mm, but they may be still immature (see Part 2).

Occurrence:–Not uncommon in the prolific part of the Zone of *Metaplacenticeras subtilistriatum* in the Wembets-Rubeshbe and the Uttsu.

Genus *Mesopuzosia* Matsumoto, 1954

Type species:–*Mesopuzosia pacifica* Matsumoto, 1954 (original designation).

Remarks:–See Matsumoto, 1954b (p. 79) for the generic diagnosis and distinctions from related genera. As has been already stated originally, there are apparently transitional species from *Puzosia* Bayle, 1878 to *Mesopuzosia*. Therefore, some authors prefer to rank *Mesopuzosia* down to a subgenus of *Puzosia*. Morphologically and also biostratigraphically there are good

reasons to keep *Mesopuzosia*. In this paper it is treated as an independent genus at least for brevity.

Mesopuzosia densicostata Matsumoto, 1954

Pl. 2, Figs. 1–2

1954. *Mesopuzosia densicostata* Matsumoto, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 5, no. 2, p. 87, pl. 22, figs. 1, 2.

Material:–GK. H5965 and M. N. 532 collected by M. Nihongi and another of T. Nishino's Collection from loc. T 5011, Uttsu.

Descriptive remarks:–GK. H5965 is a large shell, crushed to several pieces, including a small nucleus. M. N. 532 is small but has the last septum at H = 31.0, B = 23.3 mm (B/H = 0.75). They are identified with the named species in their compressed whorl, narrowly arched venter, numerous, closeset ribs, with predominant longer ones, which are gently flexuous on flank and moderately projected on venter. The last part of the large specimen was smooth but destroyed. The next inner whorl figured in Pl. 2, fig. 1, which is septate, resembles *Canadoceras multicostatum* Matsumoto, 1954 of a similar size in ribbing and shell-form, but this similarity is a homoeomorphy. Still inner whorls show the characters of *Mesopuzosia* in the compressed shell form, mode of ribbing, constrictions without tubercles and the sutural pattern.

Occurrence:–Rarely found in the silty fine-grained sandstone of the Zone of *M. subtilistriatum* at loc. T 5011, the Uttsu. The range of this species was previously recorded as Santonian and Lower Campanian but it is now extended to Upper Campanian.

Family Pachydiscidae Spath, 1922

Genus *Anapachydiscus* Yabe et Shimizu, 1926

Type species:–*Parapachydiscus fascicostatus* Yabe, 1921.

Diagnosis:–Shell large at adult stage and rather involute. Whorl broader than high, with inflated flanks and broadly arched venter, smooth and constricted at first, then with umbilical bullae or tubercles and fine straight or slightly curved, radial ribs; finally ornament may disappear in some species but coarse and distant ribs may appear in some other species. Suture of *Pachydiscus* type, finely and deeply incised.

Remarks:–The relief of tubercles and the mode of ribbing may vary with growth and between species. The type species has long umbilical spines which are apt to be detached at the septum from the basal bullae. *A. deccanensis* (Stoliczka, 1865) has shorter spine with a rounded base. Some other species have no spines.

The ribs on the outer whorl of *A. wittekindi* (Schlüter, 1876) are as strong as those of some *Eupachydiscus* species, but the whorl of *A. wittekindi* is as broad as that of the typical species of *Anapachydiscus*.

Neopachydiscus Yabe et Shimizu, 1926, established on the type species *Pachydiscus naumanni* Yokoyama, 1890 is better to be retained as a subgenus of *Anapachydiscus*. Its diagnosis is the periodic constrictions with accompanied major ribs persisting up to the outer whorl. Its shell form and suture are similar to those of *A.* (*Anapachydiscus*). *Pachydiscus boulei* Collignon, 1931, from the Santonian of Madagascar, which was later referred to

Lewesiceras by Collignon (1955, p. 77) but has narrower stems of sutural elements, *Pachydiscus patagonicus* Paulcke, 1907, from the Upper Cretaceous of Patagonia, which was designated as the type species of *Hoepenites* Collignon, 1952 (see Collignon, 1955, p. 14) and probably *Patagiosites* aff. *P. amarus* (Paulcke) of Spath (1953, p. 39, pl. 10, fig. 7) from Graham Land, are, in my opinion, examples of *A.* (*Neopachydiscus*).

The species to be described in this paper are *A.* (*Anapachydiscus*) and the subgeneric indication is omitted for brevity.

Age and distribution:–*Anapachydiscus* occurs commonly in the Santonian and Campanian of Japan, but I have seen its occasional occurrence in the Coniacian. The genus has been recorded, outside Japan, from Sakhalin, Alaska, California, Patagonia, Antarctica, South Africa, Madagascar, southern India and Europe. The record from New Zealand should be noted, but *Anapachydiscus* sp. nov.(?) of Henderson (1970, p. 62, pl. 15, fig. 2) is too poorly preserved.

Anapachydiscus fascicostatus (Yabe, 1921)

Pl. 4, Figs. 1–2; Pl. 5, Fig. 2; Pl. 8, Fig. 7; Text-fig. 4

1921. *Pachydiscus* (*Parapachydiscus*) *fascicostatum* Yabe, *in* Yabe & Shimizu, *Sci. Rep. Tohoku Imp. Univ.*, 2nd ser., vol. 5, no. 3, p. 57, pl. 8, fig. 5; pl. 9, figs. 2–5.
1926. *Anapachydiscus fascicostatum* (Yabe); Yabe & Shimizu, *Proc. Imp. Acad.*, vol. 2, p. 172.
1954. *Anapachydiscus fascicostatus* (Yabe); Matsumoto, *Cret. System Japan. Isl.*, p. 273, pl. 23(7), fig. 3; text-fig. 39(13).

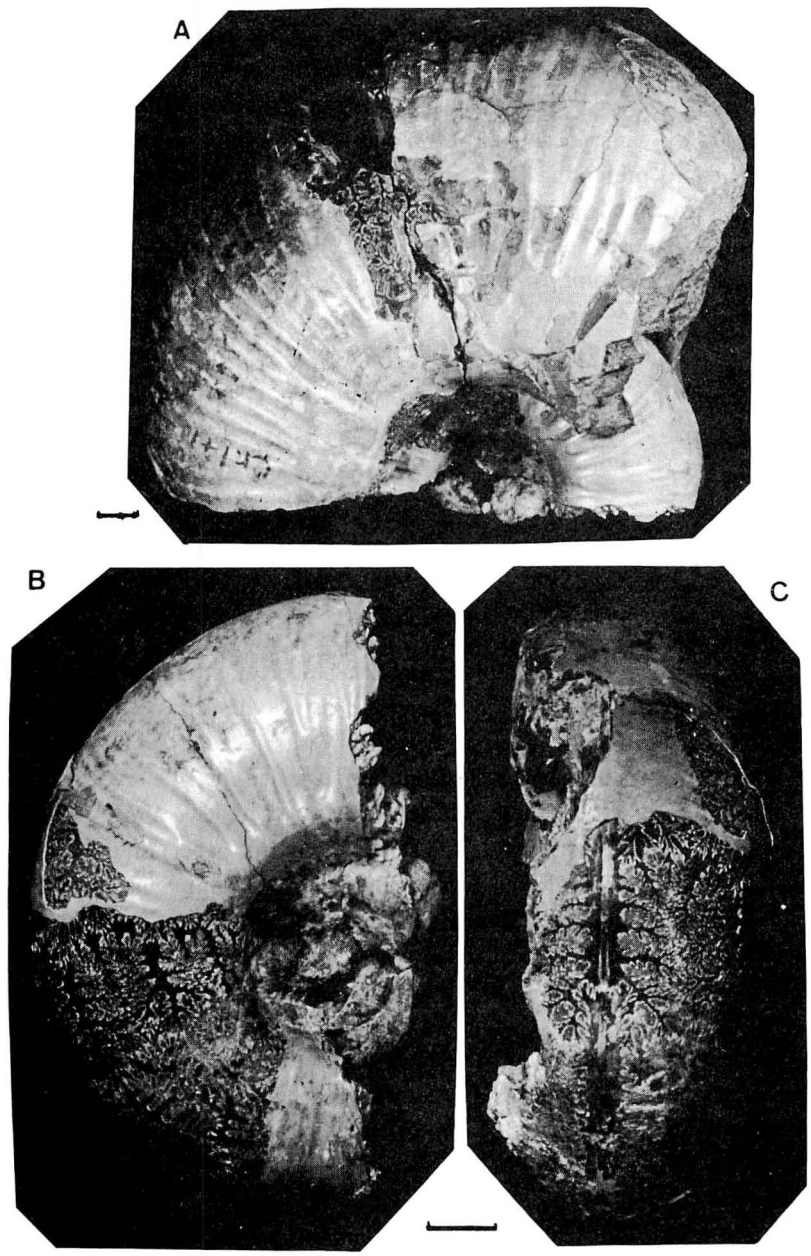
Holotype:–UMUT. MM6764 (=GT. I-386) (Yabe, 1921, pl. 8, fig. 5; pl. 9, figs. 2–5) (Text-fig. 4 of this paper), from the Tan-no-sawa (previously called Nutapetkoma), a tributary of the Abeshinai, which itself is a left branch of the River Teshio. Judging from the dark coloured silty lithology and Yabe's record, the holotype certainly came from the bed characterized by *Metaplacenticeras subtilistriatum*.

Material:–GK. H5936 and GK. H5937 from loc. E45 of the Wembets-Rubeshbe, obtained by M. Yamashita and donated through T. Matsumoto to Kyushu University; GK. H5938 from loc. T5011 of the Uttsu (T. M. Coll). I have also examined several more specimens in the private collections of T. Takahashi (Mikasa) and T. Shimanuki from the Uttsu and the Wembets-Rubeshbe of which one of the former (TTC. 460615) is illustrated in this paper (Pl. 8, Fig. 7).

Diagnosis:–Shell large, fairly involute and fairly narrowly umbilicate. Whorl much broader than high, with inflated flanks, rounded umbilical shoulders and broadly arched venter. Ribs fine, numerous, nearly rectiradiate, without or with only slightly forward ventral curve. More or less frequent umbilical tubercles, with bullate basal elevation demarcated by a septum and vertically elongated spine. Several ribs fasciculate from the base of the umbilical tubercle, in addition to inserted ribs without tubercle and also a few others arising from narrow and weak umbilical bulla. Suture very finely and deeply incised from fairly early growth-stage (e.g. 30–40 mm in diameter) onward.

Description:–The characters of th phragmocone are fairly constant as described in the above diagnosis. The proportion of B/H decreases gradually with growth.

Regretably, the characters of the adult body-chamber are not precisely known. Two possible alternatives can be considered from the available material. One is the weakening and smoothing of the ornament as in many other species of *Anapachydiscus*. The other is, on the contrary, the sudden development of strongly erected, rectiradiate ribs, which are



Text-fig. 4. *Anapachydiscus fascicostatus* (Yabe)
Holotype, UMUT. MM 6764, from the Tan-no-sawa. Lateral view of the whole specimen (A); lateral (B) and ventral (C) views of the inner whorl. Scale bar: 10 mm. (Photos by courtesy of Dr. I. Hayami.)

fairly distant on the main part but approximated on the apertural part. They cross the venter radially without decreasing strength. The latter is shown by the large specimens (about 45 cm in diameter) found at locs. E42 and T5009. The specimens themselves are of private collections, but another fragmentary body-chamber, which shows quite similar characters as above, came from the same bed at the same locality (T5009) and is now kept at Kyushu University (GK. H5939). I am inclined to prefer the latter case, because the phragmocone of that specimen, though not perfectly preserved, is indistinguishable from *A. fascicostatus*, here redefined and because other examples (mostly phragmocones) occur not uncommonly from the same zone (i.e. Zone of *Metaplacenticeras subtilistriatum*).

Dimensions:–

Specimen	D	U	H	B	B/H
Holotype	–	–	74.5	94.0	1.26
" (inner whorl)	94.5	25.0 (.26)	42.0 (.44)	55.0 (.58)	1.31
GK. H5936	97.8	25.6 (.26)	45.0 (.46)	59.0 (.60)	1.31
GK. H5937	–	–	68.5	85.0	1.24
GK. H5938	–	–	25.2	36.5	1.45
TTC. 391101	158.5	40.0 (.25)	73.0 (.46)	94.0 (.59)	1.29
TTC. 460615	55.0	14.5 (.26)	23.0 (.42)	33.0 (.60)	1.43

Comparison and discussion:–The spinose umbilical tubercle extended vertically from the umbilical shoulder is characteristic of this species. This was not noticed by Yabe (1921), because in the holotype spine was taken away and only its peculiar septate base remained. Well preserved specimens in subsequent collections have revealed the true features. Now we can judge the lost spine from its septate base, whose peculiar aspects have already been described in detail by Yabe (1921, p. 58, pl. 9, figs. 2–5) (Text-fig. 4 in this paper) on the holotype.

Matsumoto (1954a, p. 273) referred several specimens from the Santonian of Hokkaido and Sakhalin to *A. fascicostatus,* but this is now doubtful. Indeed they are very similar to this species in shell-form, but the long spine has not yet beeen confirmed in them. Their tubercles are generally more numerous and more frequent, whereas less numerous (i.e. two or three) ribs arise from a tubercle, and the ribs show a forward concave curvature on the flank and are moderately projected on the venter. The body-chamber which is presumed to represent the Santonian species is nearly smooth. The above observations suggest that the Santonian form is better regarded as distinct from *A. fascicostatus* rather than a variety of it. Anyhow, we should search for more and better preserved representative specimens to define clearly that Santonian species.

Anapachydiscus wittekindi (Schlüter, 1876) (=*Ammonites robustus* Schlüter, 1872), from the Campanian of Germany and Madagascar, has fairly strong ribs which appear from earlier stage and are gently curved. The difference in ornamentation on the septate whorl is distinct between *A. fascicostatus* and *A. wittekindi*.

Occurrence:–Zone of *Metaplacenticeras subtilistriatum* in the Tan-no-sawa, the Wembets-Rubeshbe and the Uttsu of the Teshio Mountains.

Genus *Menuites* Spath, 1922

Type species:–*Ammonites menu* Forbes, 1846.

Remarks:–For the general account of this genus see Matsumoto (1955, p. 156–157 and 178).

Menuites and other bi- or tri-tuberculate genera of the Pachydiscidae have respective counterpart genera of normal pachydiscids with umbilical tubercles alone. The species of the former are always smaller than those of the latter. Therefore the possibility of the dimorphic pair should be considered. This should be examined not only from the morphological characteristics but also from the stratigraphic occurrences. Although the available evidence is not sufficient for a definite conclusion, the specimens from the Upper Campanian of the Teshio Mountains are interesting for this problem.

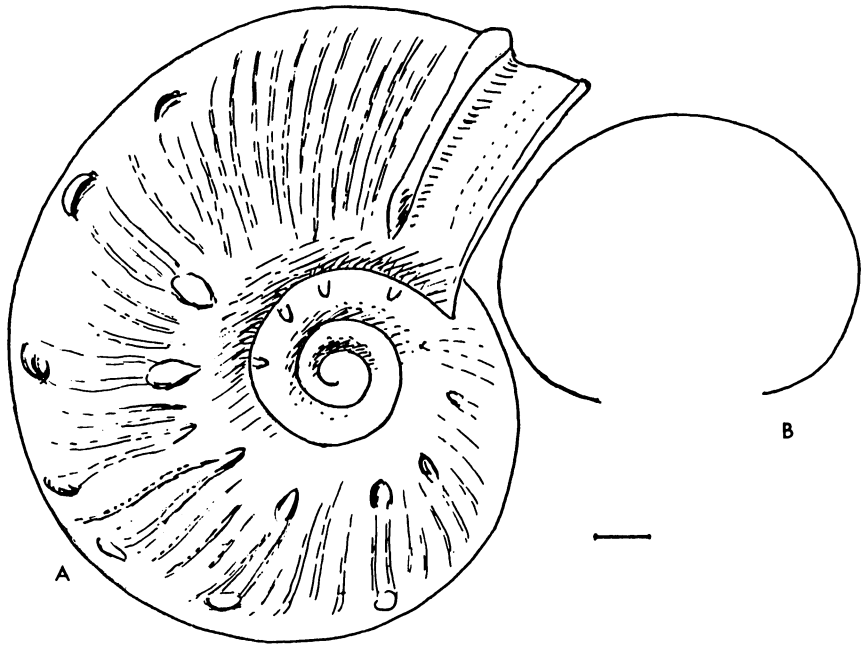
Menuites sanadai sp. nov.

Pl. 5, Fig. 1; Text-fig. 5

Material:–Holotype, GK. H5969 (=KSC. 460616) (Pl. 5, Fig. 1), collected by K. Sanada from loc. T5011, the Uttsu. Paratype (Text-fig. 5) T. Shimanuki's Collection from loc. E42, the Wembets-Rubeshbe.

Diagnosis:–Shell of medium size, moderately involute and fairly narrowly umbilicate. Whorl much broader than high, with inflated flanks, rounded umbilical shoulders and broadly arched venter.

Numerous fine and weak ribs nearly rectiradiate on flank and gently curved forward on venter. Fairly distant tubercles (9 per whorl in the holotype) upright at the umbilical shoulder



Text-fig. 5. *Menuites sanadai* sp. nov.
Paratype, T. Shimanuki Coll. from loc. E 42, Wembets-Rubeshbe. Sketch of lateral view (A) and whorl-section (B). Scale bar=10 mm. (T. Matsumoto *delin.*)

and spinose on top but septate and bullate at the base. Last portion of the phragmocone and the main part of the body-chamber bituberculate. Several fine ribs arising from the umbilical tubercle looped at the ventrolateral tubercle. The last quarter whorl free form tubercles and only finely ribbed; finally marked with constriction which is accompanies by a raised rib.

Suture finely and deeply incised as that of *Anapachydiscus fascicostatus*. Siphuncle comparatively of large diameter.

Remarks:–The holotype is a phragmocone. The paratype is nearly complete, having the body-chamber for about 210°. Its phragmocone is quite similar to the holotype.

Dimensions:–

Specimen	D	U	H	B	B/H
Holotype	81.3 (1)	22.8 (.28)	33.5 (.41)	46.0 (.57)	1.37
Paratype (–30°)	120.0 (1)	31.0 (.26)	51.0 (.43)	68.0 (.43)	1.33
M. menu	72.0 (1)	19.2 (.27)	31.0 (.43)	38.5 (.53)	1.24

Comparison and discussion:–This species is similar to *Menuites menu* (Forbes) (see Matsumoto, 1955, p. 158, text-figs. 1, 2), from India, but the former is nearly twice as large as the latter at the full-grown stage and has somewhat broader whorls and numerous fine ribs besides the tubercles.

In shell-form and ornamentation, as well as sutural pattern, the phragmocone of this species closely resembles the immature shell of *Anapachydiscus fascicostatus* (Yabe) described above. In the paratype the upright umbilical tubercles as those of *A. fascicostatus* are preserved. The bituberculate character and the small size of the adult shell is the distinction from *A. fascicostatus*.

M. sanadai and *A. fascicostatus* could be interpreted as constituting a dimorphic pair, although the microconch, *M. sanadai,* has no lappets nor rostrum. The two forms occur in the same zone, but *M. sanadai* is less common than *A. fascicostatus*.

Occurrence:–Rarely found in the Zone of *Metaplacenticeras subtilistriatum* of the Teshio Mountains.

Genus *Canadoceras* Spath, 1922

Type species:–*Ammonites newberryanus* Meek, 1876.

Remarks:–A detailed account of this genus was given by Matsumoto (1954a, p. 290–295) and more concise diagnosis by Matsumoto (1959b, p. 52–53).

Canadoceras occurs fairly commonly in the Campanian of the Pacific coast of North America, Sakhalin, Japan and also Madagascar. The earliest species, *C. yokoyamai* (Jimbo, 1894), begins to appear in the Upper Santonian and the latest ones, *C. jonesi* Collignon, 1971 and *C. tanii* Matsumoto et Morozumi, 1980 from the Lower Maastrichtian.

Canadoceras multicostatum Matsumoto, 1954

Pl. 3, Figs. 1–3

1954. *Canadoceras multicostatum* Matsumoto *In* Matsumoto (ed.): *The Cretaceous System in the Japanese Islands,* p. 304, pl. 34, figs. 1, 2; text-fig. 28(74).

Material:–GK. H5934 (Pl. 3, Fig. 3) from loc. E42-3, GK. H5935 (Pl. 3, Fig. 2) from loc. E42-2 (both T. M. coll.); T. Nishino's Coll. (Pl. 3, Fig. 1) from loc. T5010; K. Sanada's Coll. from Rubeshibe; T. Takahashi's Coll. from loc. T5009; S. Hattori's Coll. from Major Belt Shaft 390 m, Chikubetsu Colliery.

Original types:–Holotype UMUT. MM9118 (=Gt. I-1444) (Matsumoto, 1954a, pl. 34, fig. 1, text-fig. 28(74)), from Togushi-20-825, "Nishinotoro" peninsula, South Sakhalin; 7 paratypes from the same area and 4 from the Ryugase Group of the Naibuchi area, South Sakhalin, of which UMUT. MM6851 (=GT. I-2803) from N465c, Member Rby, was illustrated (Matsumoto, 1954a, pl. 34, fig. 2). GK. H3457 from the Urakawa area, southern central Hokkaido was mentioned as a probably referable specimen.

Diagnosis:–Shell very large at the full-grown stage. Whorls comparatively compressed, especially in late growth-stages. Up to the middle growth-stage, constrictions, major ribs and umbilical tubercles distinct; ribs numerous, of unequal length, closely set and gently projected on the ventral part. On the large outer whorl of late growth-stage, the constrictions, major ribs and umbilical tubercles much weakened and may finally disappear, whereas the numerous ribs persist with a considerable ventral projection. Shell may be almost smooth at the last stage.

Description:–Several fragmentary specimens are available. They are, however, well comparable with the whorls of middle to late growth-stages in the original description.

A small but good specimen in T. Nishino's Collection (Pl. 3, Fig. 1) exemplifies an immature shell, which is as widely umbilicate as the holotype and has well marked constrictions, associated major ribs and distinct umbilical tubercles from an early growth-stage (with diameter of about 3 mm). The preserved outer whorl, with heights of 10–13 mm, has numerous, fairly crowded ribs which show a gentle projection on the ventral part. Aside from the distinct umbilical tubercles of the periodic major ribs, there are several weaker umbilical bullae from which two or three ribs arise in addition to the non-tuberculated ones. The whorl is slightly higher than broad or nearly as high as broad even at this immature stage.

Another small specimen in K. Sanada's Collection is similar to the above, but more narrowly umbilicate.

On the larger specimens descriptive remarks are given below (under *comparison*).

Dimensions:–

Specimen	D	U	H	B	B/H
Holotype	82	29 (.35)	32	28	0.87
"	44	22 (.35)	16	16	1.0
GK. H5934	(second. deformed)		90	60	0.66
GK. H5935	–	–	44.8	32.8	0.73
Hattori's	–	–	72.5	46.5	0.64
Nishino's	33.0	12.0 (.36)	12.6	11.8	0.94
Sanada's	26.0	6.7 (.26)	11.0	10.7	0.97

Comparison and discussion:–The large paratype, GT. I-2803 (=UMUT. MM6851) (Matsumoto, 1954a, pl. 34(18), fig. 2) was affected by erosion on the umbilical part which was not overlapped by a still outer whorl. Originally the ribs must have existed on this apparently smooth part.

GK. H5934 and S. Hattori's specimen well show the ribbing of this late growth-stage.

There are longer and shorter rib; longer ones arising from the umbilical margin and some of them have bullate weak tubercles at the umbilical shoulder. Shorter ribs arise at or slightly above the umbilical shoulder. All the ribs are projected moderately on the ventral part. The mode of ribbing at this stage is apparently similar to that of a certain species of *Mesopuzosia,* e.g. *M. indopacifica* (Kossmat), but the umbilical tubercles and the *Pachydiscus* type suture are the prime distinction.

The small immature shell of this species resembles that of *C. newberryanum* (Meek) (see Usher, 1952, pl. 6, figs. 1–5, 7–10), but the latter has somewhat broader whorl and coarser ribs at the corresponding growth-stage.

Occurrence:–Summarizing the locality records of the described specimens, *C. multicostatus* occurs in the Zone of *Metaplacenticeras subtilistriatum* in the Teshio Mountains. It is found sometimes (as in K. Sanada's Collection) in the same nodule as *M. subtilistriatum.* The bed in the Chikubetsu Colliery containing this species has been assigned by Hattori (1965) to the Penkezawa Siltstone, i.e. the lower member of the tripartite Haranosawa Formation, a local name for the Hakobuchi Group (="Yasukawa Group") in the Teshio Mountains.

As will be recorded in Part II, in the Soya area of northern Hokkaido, *C. multicostatum* occurs also in several beds which are lower than the *Metaplacenticeras* bearing bed as well as in the latter.

The stratigraphic range of *C. multicostatum* is generally higher than that of *C. kossmati,* although they overlap partly. It is from the upper part of the Zone of *Inoceramus schmidti-Canadoceras kossmati* to the upper part of the Zone of *Metaplacenticeras subtilistriatum.* Therefore, *C. multicostatum* in Japan and Sakhalin is nearly contemporary with *C. newberryanum* in the Pacific Coast Province of North America.

Superfamily Hoplitaceae H. Douvillé, 1890
Family Placenticeratidae Hyatt, 1900
Genus *Metaplacenticeras* Spath, 1926

Type species:–Placenticeras pacificum Smith, 1900.

Generic diagnosis:–Adult shell small to moderate or fairly large, depending on species. Shell-form in late growth-stages compressed, discoidal, involute and narrowly umbilicate. Whorl much higher than broad, with flat convergent flanks. Venter narrow, demarcated by marginal keels and provided normally with a median keel.

Shell ornamented with sigmoid or falcoid ribs which start from the umbilical tubercles, showing bifurcation or multiple branching or intercalation, and projected forward on the ventrolateral part, giving weak or moderately distinct serrations or undulations on the marginal keels. Fine lirae and/or striae may be combined with the ribbing.

Suture florid and of diagnostic pattern. Four prominent "apparent lobes" on the outer half of the flank in late growth-stages developed from the three lobules of tripartite L (marked here Lv Lm Ld) *plus* a true adventive lobe (A) on the inner (=dorsal) side of the first lateral saddle. The heads of the saddles between these four lobes aligned on an oblique line descending from the ventrolateral part to the middle of flank with a gently concave curvature. Another adventive lobe developed on the ventral side of the original second lateral saddle (between original L and U2). Small lobes on the inner half of the flank, consisting of U2, U4 and two or three auxiliaries (U5(=S)), aligned nearly straightly. There is a characteristic zigzag at about the middle of the flank between the above mentioned outer and inner lines of disposition.

Remarks:–Spath (1926, p. 79) established *Metaplacenticeras* on *P. pacificum* Smith for the reason of the difference in suture from *Placenticeras*, without explanation in details. Reeside (1926) described carefully the comparison between *M. pacificum* and *Placenticeras meeki* Boehm, showing the ontogenetic development of the sutures in the two species, although that of *M. pacificum* was adapted from the distinguished work of Smith (1900). The ontogeny of another species of *Metaplacenticeras, M. subtilistriatum* from Japan, was studied by myself (Matsumoto, 1953). The above expression of the suture depends on my own work as well as on Smith's.

The three prominent lobes on the outer half of the flank in *Placenticeras* can be interpreted as A2, A1 and L on the basis of Reedide's illustration. Therefore, the placenticeratoid sutural pattern of *Metaplacenticeras* may be a homoeomorphy. My old presumption (Matsumoto, 1953) that *Metaplacenticeras* may have its ultimate origin in *Phylloceras* is of course untenable, but whether *Metaplacenticeras* is directly connected with *Placenticeras* or not is questionable. Therefore, the assignement of *Metaplcenticeras* to the family Placenticeratidae is provisional.

Reeside (1926) considered *Hoplitoplacenticeras* as synonymous with *Metaplacenticeras* but avoided to use Paulcke's (1907) peculiar nomenclature. In fact, some of the specimens described under *M. californicum* (Anderson) (e.g. Anderson, 1902, pl. 8, figs. 174–175; Reeside, 1926, pl. 2, figs. 14–16) are examples of *Hoplitoplacenticeras*. In the ontogenetic development of suture, *Metaplacenticeras* is somewhat allied to *Hoplitoplacenticeras*, but the florid placenticeratoid pattern is better manifested in the former. The two genera should be distinguished. *Hoplitoplacenticeras* has submarginal tubercles in addition to the umbilical and the paired ventral ones, no median keel but a ventral groove. Sometimes it has broader whorls and a wider umbilicus.

Anderson and Reeside were wrong in recording the geological age of *Metaplacenticeras* as Cenomanian. It is Campanian, probably Upper Campanian (Muller and Jeletzky, 1970, Ward, 1978, Matsumoto, 1959d, 1977b, 1982a, b). Incidentally the subgenus *Paraplacenticeras* Matsumoto, 1953 is unnecessary, because the distinction of *M. subtilistriatum* from *M. pacificum* is not more than specific.

Metaplacenticeras subtilistriatum (Jimbo, 1894)

Pl. 6, Figs. 1–2; Pl. 7, Figs. 1–4

1894. *Placenticeras subtilistriatum* Jimbo, *Palaeont. Abh.*, N. F., vol. 2, p. 171, pl. 17, fig. 1.
1953. *Metaplacenticeras (Paraplacenticers) subtilistriatum* (Jimbo), Matsumoto, *Japan. Jour. Geol. Geogr.*, vol. 23, p. 140, pl. 13, figs. 1–4; text-figs. 1–9.
1963. *Metaplacenticeras subtilistriatum* (Jimbo); Matsumoto, *A Survey of Fossils from Japan Illustrated in Classical Monographs*, p. 42, pl. 60, fig. 1.
1979. *Metaplacenticeras subtilistriatum* (Jimbo); Matsumoto, *Atlas of Japanese Fossils*, no. 51, sheet 306, pl. Cr-63, figs. 4, 5.

Lectotype:–Jimbo (1894) established this species on at least two specimens (syntypes), of which the illustrated one, UMUT. MM7502 (=GT. I-88) (Jimbo, 1894, pl. 1, fig. 1, 1a; Matsumoto, 1953, pl. 13, fig. 1a, b), from the Wembets-Rubeshibe is designated here as the lectotype. The type locality is on the western side of the Teshio Mountains and not a tributary of the Abeshinai (erroneously written by Matsumoto, 1953, p. 140). Another syntype, GT.

I-89 (without UMUT. number) is from the Nutapetokoma (=Tan-no-sawa), a tributary of the Abeshinai on the eastern side of the Teshio Mountains.

Material:–Of a large number of specimens before me, representative examples are as follows:

GK. H4001 (Matsumoto, 1953, pl. 13, fig. 2a, b), H4002 (*Ditto,* pl. 13, fig. 3a, b), H4003 (*Ditto*, pl. 13, fig. 4a–c), H4004 and H4005 from the Abeshinai-Rubeshibets. GK. H5945 (Pl. 7, Fig. 2), H5946 (Pl. 7, Fig. 1), H5948 (Pl. 7, Fig. 4), H5953a–c and H5956 from loc. E33, GK. H5949 and H5952 from loc. E32, GK. H5947 (Pl. 7, Fig. 3), H5950a–c and H5951 from loc. E42, all in the Wembets-Rubeshibe; GK. H5958a–d from loc. T5011 in the Uttsu. TTC. 480814 (Pl. 6, Fig. 2), TTC. 571009 and TSC. unnumbered from the Wembets-Rubeshbe; TTC. 410817 (Pl. 6, Fig. 1) from the Tanno-sawa (TTC. = T. Takahashi Coll.; TSC. = T. Shimanuki Coll.).

Dimensions:–

Specimen	D	U	H	B	B/H
GK. H4001	66.6	11.2 (.17)	34.6 (.52)	12 (sec. compr.)	0.35
GK. H4002	25.0	4.0 (.16)	13.4 (.54)	6.4 (.26)	0.48
GK. H4003	20.5	2.8 (.14)	11.3 (.55)	5.6 (.27)	0.49
GK. H5945	23.3	3.7 (.16)	12.3 (.53)	6.2 (.27)	0.50
GK. H5946	32.0	4.6 (.14)	17.2 (.54)	8.2 (.26)	0.48
GK. H5947	63.0	10.5 (.17)	32.2 (.51)	15.0 (.24)	0.47
GK. H5950	69.0	13.0 (.19)	33.4 (.48)	16.2 (.23)	0.48
GK. H5952	60.0	10.5 (.17)	30.3 (.50)	16.6 (.28)	0.55
TTC. 480814	93.5	19.2 (.20)	42.5 (.45)	24.0 (.26)	0.56
TTC. 410817	72.5	12.8 (.17)	35.0 (.48)	16.4 (.23)	0.47
TTC. 571009	60.0	11.2 (.19)	29.3 (.49)	15.2 (.25)	0.52
TSC. unnumb.	74.0	14.0 (.19)	34.5 (.47)	17.8 (.24)	0.52

Specific diagnosis:–Shell rather small, 50 to 90 mm in diameter at the adult stage, discoidal, involute and compressed. Whorl much higher than broad, with B/H from 0.5 to 0.7, and high trapezoidal in cross-section. Umbilicus narrow, normally 16 to 21 per cent of diameter, surrounded by low but steeply inclined wall and subangular shoulder. Flanks flat or very gently convex, convergent outward. Venter narrow, nearly flat, provided with a low median keel and demarcated by a pair of sharp keels and then passing to the flanks by way of the gently convex submarginal shoulders. The median keel may fade away in the last stage.

Surface of immature shell nearly smooth, only with very weak, fine, sigmoid ribs and lirae on the flank, small tubercles at the umbilical shoulder and very weak serrations on the marginal keel. Mature shell provided with low falcoid to sigmoidal ribs or undulations, arising from the prorsiradiate umbilical bullae which are sharp headed and fairly prominent at the umbilical shoulder. Ribs normally bifurcated or alternated with shorter ones but sometimes single. The ribs end at the marginal keel, giving low undulations on the keel. The falcoid bending of the ribs on the earlier half of the body-chamber becoming less sharp and gradually sigmoid on the late half. On the surface of the body-chamber, fine lirae and striae marked in parallel with the sigmoid ribs but sometimes oblique to the outer half of the falcoid ribs, crossing the venter with a projection. Feather structure may be discernible on the flank under

favourable condition.

Suture as for the generic diagnosis (see above; also Reeside 1926, p. 2, pl. 1, figs. 8–12; pl. 2, fig. 13; Matsumoto, 1953, figs. 1–4, 9).

Remarks:–There is a form in which ribs are much weaker but more numerous than the above described character even on the body-chamber. It occurs in the same zone as the normal one and there are specimens which show intermediate features. Therefore this can be regarded as a variation within a species. The presence or absence of a dimorphic pair has not yet been determined with certainty. The very apertural margin is preserved in some larger specimens (Pl. 6, Fig. 2), showing an ocular sinus and a ventrolateral sinus. The length of the body-chamber is about 210°.

Jaw apparatuses are found occasionally outside the shell in the nodules with *M. subtilistriatum* in Hokkaido. I am looking for those preserved in situ in the body-chamber.

Comparison:–Metaplacenticeras subtilistriatum is similar to *M. pacificum* (Smith) (1900, p. 207, pls. 26–28) (Anderson, 1902, p. 79, pl. 8, figs. 162–164, 171–172; pl. 9, fig. 180; 1958, p. 254, pl. 37, figs. 1–4; Reeside, 1926, p. 2, pl. 1, figs. 8–12; pl. 2, figs. 6–13), from California, in the general shell-form, the falcoid to sigmoid ribs, the presence of a weak median keel on the narrow venter and the pattern of suture, but the former has more distant and less numerous ribs than the latter. The rib branching is multiple in *M. pacificum*. The adult shell of *M. subtilistriatum* is smaller than that of *M. pacificum*.

M. californicum (Anderson) 1902, p. 78, pl. 8, fig. 178), which is redefined on the neotype (Anderson, 1958, p. 254, pl. 36, fig. 1) is somewhat smaller and has coarser and stronger ribs than *M. pacificum*. I presume that the two contemporary nominal species might be a dimorphic pair, although the available evidence is insufficient. Anyhow, the ribs of *M. californicum* are denser and more numerous than those of *M. subtilistriatum*.

Occurrence:–Abundant at localities E11, E33, E42, E44, E45 and E46 in the Wembets-Rubeshbe; T5011, T5010, T5009 and T5004 in the Uttsu; several other localities in the upper reaches of the Saku-gakko-no-sawa, the Abeshinai-Rubeshibetsu and the Tan-no-sawa, tributaries to the Abeshinai, forming a zone in the Teshio Mountains.

Genus *Hoplitoplacenticeras* Paulcke, 1907

Type species:–Hoplites plasticus Paulcke, 1907 (ICZN Opinion 554); the lectotype of the species is Paulcke, 1907, pl. 13, figs. 1, 1a–d (see Howarth, 1965, p. 391).

Generic diagnosis:–Shell small for the family and moderately involute, with fairly narrow umbilicus. Whorl section typically trapezoidal but may be compressed in some forms, with more or less narrow, flat venter, which may be grooved between paired rows of ventral (i.e. outer ventrolateral) clavate tubercles in some species.

Ribs and tubercles variable in coarseness, density and disposition. Typically ribs prorsiradiate, more or less flexuous, with bifurcated or intercalated secondaries, but may be nearly rectiradiate in some forms. As a rule they cross the venter though somewhat weakened. Tubercles in six rows, i.e. umbilical, inner ventrolateral and outer ventrolateral. In some species umbilical tubercles may be so shifted upward that they may be called lateral tubercles.

Suture fundamentally similar to that of *Metaplacenticeras,* but less florid with generally broader stems of saddles.

Remarks:–As in the case of *Metaplacenticeras*, the phylogenetic origin of *Hoplitoplacenticeras* has not yet been made clear. Hence, the genus is provisionally assigned to the Placenticeratidae. From its suture and other characters I presume a possibility of its ancestry in some form of extremely variable *Pseudoschloenbachia*, but the available evidence is yet insufficient.

Hoplitoplacenticeras includes a considerable number of species which occur in various regions of the world. Although a taxonomic restudy may be needed on some of them, reliable stratigraphic data show that the majority of them occurs in the lower part of the Upper Campanian and that a few of them may range upward. The records of the stratigraphic distribution of the representative species were examined carefully by Cobban (1963) and Howarth (1965). They are not repeated here.

A few specimens recently found in Hokkaido are different from any of the species hitherto described outside of Japan.

Hoplitoplacenticeras monju Matsumoto

Pl. 7, Fig. 5; Pl. 8, Fig. 6

1982. *Hoplitoplacenticeras monju* Matsumoto, *Proc. Japan Acad.*, vol. 58, ser. B, no. 8, p. 244, figs. 1–2.

Material:–Holotype, GK. H5933 (Pl. 7, Fig. 5), collected by M. Yamashita from loc. E33, Wembets-Rubeshube, and donated to Kyushu University through T. Matsumoto. Paratype, GK. H5966 illustrated small specimen (Pl. 8, Fig. 6) collected by Y. Kawashita from the Tan-no-sawa and donated likewise to Kyushu University.

Diagnosis:–Shell small, moderately involute, with comparatively wider umbilicus for the genus. Whorl somewhat broader than high, with broad subtrapezoidal section and nearly flat broad venter on which inner and outer ventrolateral tubercles in four rows are disposed at nearly the same level.

Primary ribs fairly coarse and prorsiradiate, bearing spinose tubercles slightly below mid-flank, rounded to somewhat clavate strong tubercles at the ventrolateral shoulder and rounded or clavate ventral tubercles on either side of the siphonal zone. Secondary ribs intercalated between or branched from primary ribs. Secondaries on adult whorl narrower than primaries, bearing independent smaller tubercles or looped at larger tubercles on the primaries.

Etymology:–Monju (Manjusri in Sanskrit) is a divinity of knowledge who serves the Buddha on His left side.

Dimensions:–

Specimen	D	U	H	B	B/H
Holotype	45.0 (1)	12.7 (.28)	20.0 (.44)	23.8 (.53)	1.19
Paratype	8.4 (1)	2.1 (.25)	4.0 (.47)	4.4 (.52)	1.10

Description:–The last suture is partly exposed at H = 15.5 mm in the holotype, hence the body-chamber is preserved for about 100°. The ornamentation of the adult stage looks rather irregular. The primary ribs are strong and have prominent, spinose lateral tubercles, moderately strong, somewhat clavate inner ventrolateral tubercles and slightly weaker, somewhat clavate outer ventrolateral tubercles. Doubled minor ribs are sometimes superimposed on the major ones. This may be interpreted that bifurcated ribs on the extension of the primaries are looped at the tubercles. In addition to them narrower secondaries are intercalated

between or distinctly branched from the coarser primaries. Some of them are looped at the tubercles on the primaries and others extend to the ventral part, bearing independent smaller tubercles. Some others of the intercalated secondaries are nearly as long as but narrower and weaker than the primaries. On the venter there occur occasionally still narrower, weaker and shorter ribs, bearing small outer ventrolateral tubercles. They may be called the tertiary ribs. All the ribs cross the venter with a gently forward curvature.

On the next inner whorl of the holotype, with diameters of about 20 to 10 mm, the primary ribs are coarse, separated by wider interspaces and prorsiradiate. The lateral tubercles on them are aligned along the umbilical seam of the outer whorl and are spinose. The still inner whorl, which is as large as the paratype, shows regular ribbing on the side.

The paratype is very small but beautifully preserved. Its primary ribs are somewhat prorsiradiate on the inner half of the flank with strong tubercles below the mid-flank, where ribs are bipartite and occasionally intercalated with additional ribs. All the ribs on the outer part of the whorl are regular in strength and disposition, bearing small but distinct tubercles in four rows. The paired ventral tubercles on either side of the siphonal zone look at first somewhat (but not quite) alternated, arranged in chevrons; on the main part they are opposite, lying on the ribs which are gently curved forward on crossing the venter.

Suture is partly seen on the holotype; a part of lateral saddle on the last whorl and tripartite L and adjacent parts on the inner whorl. It is of *Hoplitoplacenticeras* pattern.

Comparison:—This species resembles a comparatively thick whorled and coarsely ornamented variety of *H. plasticum* (Paulcke), called "*Hoplites plasticus-crassus* Paulcke" (1907, p. 27, pl. 11, fig. 1, 1a–c; text-figs. 9–12), from the Campanian of Patagonia, but its adult shell has more numerous ribs with more frequent intercalation and branching of minor ribs and its inner ventrolateral tubercles on the primary ribs are stronger and clavate. The depressed zone between the inner ventrolateral tubercles is distinct in the Patagonian form but is almost negligible in ours.

H. monju resembles also *H. trangahyense* Collignon (1970, p. 76, pl. 638, fig. 2347), from the Upper Campanian Zone of *H. marroti* of Madagascar, in the shell-form and the general configuration of the ornament. On the body-chamber of the former there are some independent minor (narrower and shorter) ribs which have smaller tubercles at the positions corresponding to the stronger tubercles on the major ribs, whereas in the latter the minor ribs are all looped at the lateral and the ventrolateral tubercles, which are all more massive and less numerous than in the former.

Occurrence:—E33, Wembets-Rubeshbe (type locality) and Tan-no-sawa, occurring rarely in the Zone of *M. subtilistriatum* in the Teshio Mountains.

Hoplitoplacenticeras fugen sp. nov.

Pl. 8, Fig. 5

Material:—Holotype GK. H5960, collected by A Tomita from loc. E33 and kindly donated to Kyushu University through T. Matsumoto.

Diagnosis:—Small shell of moderate involution with fairly narrow umbilicus. Adult whorl somewhat higher than broad with subtrapezoid-subpolygonal section, broadest at the site of lower lateral tubercle which is shifted upward from the umbilical shoulder.

Ribs flexuous, projected on the ventrolateral part, denser and more numerous with more

frequent bifurcation or intercalation on the body-chamber than on the phragmocone. Three rows of tubercles, the first somewhat below the mid-flank, the second at the ventrolateral shoulder and the third ventral one on either side of the ventral groove. Small spines on the ventral tubercles single or bipartite or occasionally tripartite.

Suture less deeply incised than that of *H. plasticum*.

Etymology:–Fugen (=Hugen in Roman letters) (Visvabhadra in Sanskrit) is a divinity of mercy and wisdom who serves the Buddha on His right side.

Dimensions:–

Specimen	D	U	H	B	B/H
Holotype	20.0	4.6 (.23)	10.0 (.50)	~8 (.4)	~0.8

Description:–The holotype is a single specimen available at present for this species. It does show distinctive characters, but I do not know the extent of variation. Its diameter is 15 mm at the end of the phragmocone and the preserved part of the body-chamber is about 150°, which may have been originally somewhat longer. As the ornament changes remarkably from the phragmocone to the body-chamber, this specimen represents probably the adult stage, although it is small.

The ribs are flexuous, running somewhat obliquely forward from the umbilical margin to the site of the lower lateral tubercle where they are bent slightly backward and then curved considerably forward on approaching the ventrolateral shoulder where they are tuberculate and extend forward to the ventral tubercle at the edge of the groove on the siphonal line.

The spines on the ventral tubercles are small but peculiar in showing bipartite or occasionally tripartite shape. This feature is not perceptible on the internal mould. Whether the ventrolateral and lower lateral tubercles are spinose or not cannot be confirmed, since the outer shell layer is unpreserved for the most part, but the spines, if present, seem to be small and short.

The intensity and density of the ribbing show distinct difference between the phragmocone and the body-chamber. On the main part of the phragmocone the ribs are moderately coarse and separated by narrower interspaces, with some bifurcation or intercalation at about the mid-flank. The primary ribs number 14 or 15 per whorl in this septate stage. On the body-chamber and the preceding last portion of phragmocone the ribs are numerous and crowded, with frequent bifurcation or intercalation, consisting of 12 primaries and 12 finer secondaries in a half whorl, numbering altogether 24 on the ventral part.

Comparison:–This species is similar to *H. monju* in the configuration of tubercle rows, but it has a higher whorl, somewhat narrower umbilicus, more flexuous and more regular ribs and smaller tubercles, without looped ribs. Its tubercles on the venter are situated at higher level than those of ventrolateral shoulders.

H. fugen resembles *H. marroti* (Coquand, 1859) (see Grossouvre, 1794, pl. 8, fig. 3) (= *Ammonites vari* Schlüter, 1872; 1876), from the Upper Camanian of France, Germany, Madagascar (Collignon, 1971, p. 75, pl. 638, figs. 2342, 2343) and Texas (Young, 1963, p. 63, pl. 2, figs. 5, 15, 17; etc.) in the flexuous ribbing, but is smaller, less compressed, and provided with the lower lateral tubercles instead of the umbilical ones and a deeper ventral groove. The bipartite or occasionally tripartite spines on the ventral tubercles are characteristic of *H. fugen*.

H. cf. *H. marroti* from Angola (Howarth, 1965, p. 391, pl. 12, fig. 3; pl. 13, fig. 3) has

small umbilical tubercles and small mid-lateral tubercles both. It is again larger than *H. fugen* and its ventral groove is shallower.

Occurrence:–Loc. E33 of the Wembets-Rubeshbe. In addition to *H. fugen, Metaplacenticeras subtilistriatum* and *Desmophyllites diphylloides* are contained in the same nodule.

Suborder Lytoceratina Hyatt, 1899
Family Tetragonitidae Hyatt, 1900
Genus *Saghalinites* Wright et Matsumoto, 1954

Type species:–*Ammonites cala* Forbes, 1846 (by original designation).

Remarks:–The diagnosis and other up-to-date account of this genus have been given by Kennedy and Klinger (1977b, p. 167), whom we generally follow.

A new species is introduced below from the Teshio Mountains.

Saghalinites teshioensis sp. nov.
Pl. 9, Figs. 1–3

Material:–Holotype GK. H5971 (Pl. 9, Fig. 1) collected by K. Sanada (460116) from loc. T5011 of the Uttsu. Paratypes, GK. H5971 of T. Takahashi's collection (460615) from the Uttsu; GK. H5941 (Pl. 9, Fig. 3) of M. Yamashita's collection from loc. E45, GK. H5939 (Pl. 9, Fig. 2) and GK. H5940 of A. Tomita's collection from the Wembets-Rubeshbe; well preserved early immature shell in K. Sanada's collection from the Abeshinai-Rubeshibets. All donated to Kyushu University by courtesy of the collectors.

Diagnosis:–Shell small, with diameter of about 60 mm at the full-grown stage, evolute, overlapping slightly the ventral portion of inner whorl, and fairly widely umbilicate, with umbilical ration of 44 to 48%. Whorl somewhat broader than high, with ratio of B/H ranging from 1.13 to 1.19 in the adult stage, broader in earlier stages, subrounded in section, with low but steeply inclined umbilical wall, abruptly rounded umbilical shoulder, gently convex flanks, passing gradually to broadly arched venter. Surface nearly smooth, with very fine striae. Constrictions narrow, of moderate frequency in immature stages, 4 to 6 per whorl, except for the very early stage (below 5 mm in diameter); infrequent in the adolescent stage, 1 or 2 per whorl in late septate part to main part of body-chamber, and again frequent, 3 or 4 in the last quarter whorl; remarkably prorsiradiate on flank and bent backward at the rounded ventrolateral shoulder, showing gentle sinus on the venter. Suture comparatively simple, characterized by trifid major saddles and bifid lateral lobe. Body-chamber about 280° in length.

Dimensions:–

Specimen	D	U	H	B	B/H
GK. H5941	55.5	25.6 (.46)	16.3 (.29)	19.4 (.35)	1.19
GK. H5939	57.8	27.6 (.48)	17.5 (.30)	20.5 (.35)	1.17
GK. H5971	57.0	27.0 (.47)	16.4 (.29)	18.8 (.33)	1.15
GK. H5970	47.0	20.6 (.44)	15.0 (.32)	17.0 (.36)	1.13
Very young	7.7	3.8 (.49)	2.4 (.31)	3.2 (.41)	1.33

Description:–For some reasons, no completely preserved specimen is found in the available material. The holotype (Pl. 9, Fig. 1) shows nearly the complete figure of the right side, but the

left side of its phragmocone is not well exposed. GK. H5935 shows a finely impressed radial and spiral fine striations, which probably reflect the structure of the shell layer. GK. H5935, H5941 and the holotype exhibit well the lateral view of the inner whorl including the comparatively large protoconch. The entire shell seems to consist of 7 (more precisely 6 + ½) whorls. A well preserved young shell, measured above, was preserved in the body-chamber of Sanada's adult specimen.

Comparison:–This species is closely allied to *S. nuperus* (van Hoepen, 1921) (see Kennedy and Klinger, 1977b, p. 177, figs. 16 A–E, 17 A–B, 18; Collignon, 1956, p. 95, pl. 11, fig. 1; 1966, p. 3, pl. 456, fig. 1856; p. 21, pl. 403, fig. 1893), from the Upper Santonian and Lower Campanian of South Africa, Madagascar and Japan, but is distinguished by its wide umbilicus on an average, more evolute coiling, smaller size of adult shell and the presence of a very infrequently constricted part before the frequently constricted last quarter.

The adult shell of *S. teshioensis* is fairly similar to the immature shell of *S. wrighti* Birkelund, 1965 (p. 30, pl. 2, figs. 1–5; pl. 3, fig. 1; text-figs. 14–25), from the Maastrichtian of West Greenland, but in the adult stage the latter is larger and has a broader whorl of subtrapezoid to polygonal, instead of subrounded section, with a flatter venter and a ventral groove.

Occurrence:–Occasionally found in the Zone of *Metaplacenticeras subtilistriatum* in the Wembets-Rubeshbe, the Uttsu and the Abeshinai-Rubeshibe in the Teshio Mountains.

Superfamily Turrilitaceae Gill, 1871

This group was assigned to the suborder Lytoceratina by Wright (1957 in the *Treatise*) but has recently been transferred to the suborder Ancyloceratina Wiedmann, 1960. I have a doubt about this alteration, because almost all the ammonites belonging to the Turrilitaceae have bifid lateral lobes (L and U, unless secondarily modified), as in the coiled ammonites of the Lytoceratacеae. Ammonites of the Ancyloceratacеae have trifid lateral lobes (L and U). Despite these facts, which Wright (1981, p. 166) himself acknowledged, the Turrilitaceae have been placed in the Ancyloceratina probably because of the quadrilobe sutures.

In my opinion, the quadrilobate state of sutures is a homoemorphy in uncoiled or heteromorph ammonoids of different stocks. The Triassic Choristoceratidae of the Ceratitida have also quadrilobate sutures. The patterns of the fundamental sutural elements (E, L, U, I) should be properly evaluated.

I would evaluate also the interesting paper of Doguzhaeva and Mikhailova (1982) who have concluded that the Cretaceous heteromorphic superfamilies Turrilitaceae and the Ancyloceratacеae have independent origins and belong to two different orders, Lytoceratida and Ammonitida respectively. In other words, I favour the scheme of major classification of the Jurassic and Cretaceous Ammonoidea recently shown by Mikailova (1980) on the basis of her study on the ontogeny of the representative ammonites of the relevant groups. I should, however, like to group the suborders Phylloceratina, Lytoceratina and Ammonitina into the order Ammonitida. This matches well the phylogenetic diagram of Mikailova, in which I should read Phylloceratina, Lytoceratina and Ammonitina for Phylloceratida, Lytoceratida and Ammonitida. My scheme was written in a Japanese textbook (Matsumoto, 1974, p. 114) but a similar scheme has already been indicated in the *Osnovy* (Ruzhentsev, 1962; translation in English, 1974, p. 473, fig. 77).

Family Turrilitidae Gill, 1871
Subfamily Diplomoceratinae Spath, 1926

Various groups of the Turrilitidae are variable in themselves and there are seemingly transitional features between different groups. Therefore, I agree with Wright (1981, p. 172) to treat the taxonomic groups at subfamily level. Diplomoceratinae is one of them.

Now, several heteromorph ammonoids are found in the Zone of *Metaplacenticeras subtilistriatum* in the Teshio Mountains, but they are often too fragmentary and I should search for better preserved specimens. I know also an example of *Didymoceras* occurring in the correlative bed of the Urakawa area (southern central Hokkaido), but it is not described here. In this paper only three species are described.

Genus *Polyptychoceras* Yabe, 1927

Type species:—*Ptychoceras pseudogaultinum* Yokoyama, 1890.

Generic diagnosis:—Shell hamitid, consisting of elongated three or more reflected shafts, circular or oval or sometimes subquadrate in cross-section. The first shaft contiguous or nearly so with the second, provided with prorsiradiate ribs and periodic constrictions; later shaft slightly separated from adjacent one, encircled by radial (i.e. transverse) ribs. Suture quadrilobate; E, L, U and intervening saddles bifid; I small and pointed.

The three or more shafts are nearly on the same flat plane, but a slight deviation from this state is not uncommon. *P. obstrictum* (Jimbo, 1894) exemplifies distinctly this deviation, suggesting its derivation from some form of *Scalarites* Wright et Matsumoto. In other species the early part of the first shaft may lie upon the U-curved part from the second to the third shaft or it is enclosed between the later two shafts.

Remarks:—There are aberrant forms in which the shaft of the late stage deviates from the configuration parallel to that of the early growth-stage, showing a peculiar bending. They occur along with normal ones and have the same type of ribbing. Whether they represent a subgenus of *Polyptychoceras* or merely a variation or a pathology is a question which should be worked out in the future. Also I am looking for a better preserved material to know the very initial stage of *Polyptychoceras*.

Polyptychoceras and its sisterhood taxon *Subpychoceras* occur fairly abundantly in the Santonian of Hokkaido and other areas of Japan and range up to the Campanian. Regretably the monographic descriptions of various species are being delayed for some reasons. An example described below marks a record of a species which survived up to the age of the Zone of *M. subtilistriatum* (Late Campanian).

Polyptychoceras pseudogaultinum (Yokoyama, 1890)

Pl. 8, Fig. 4

1890. *Ptychoceras pseudo-gaultinum* Yokoyama, *Palaeontographica* vol. 36, p. 181, pl. 20, fig. 1, 2.
1963. *Polyptychoceras pseudogaultinum* (Yokoyama), Matsumoto *in* Matsumoto (ed.): *A Survey of Fossils from Japan Illustrated in Classical Monographs*, Part VII, p. 29, pl. 46, figs. 1, 2.
1979. *Polyptychoceras pseudogaultinum* (Yokoyama), Matsumoto & Nihongi, *Proc. Japan Acad.*, vol. 55, ser. B, no. 3, p. 116, fig. 1.

Syntypes:—Yokoyama (1890) illustrated three syntypes from Urakawa, but the third

one (pl. 20, fig. 3) is doubtful. One of the other two (Pl. 20, fig. 1 or fig. 2) should be designated as the lectotype, but I defer to decide it until I understand more clearly the variation of this species in the population of Urakawa.

Material:–YN. 2, illustrated specimen (Pl. 8, Fig. 4), obtained by Yasunori Nakaya (schoolboy in Nakagawa) in 1980 from loc. T5011, the Uttsu.

Dimensions:–

Specimen	Length	H	B	B/H
YN. 2. 2nd shaft	79.0	9.0	7.8	0.86
" last shaft		10.5	9.0	0.86
GK. H5894a	141.0	9.6	9.6	1.00
		10.4	–	

Description:–The shell consists of three shafts, which are nearly straight but strictly speaking gently arcuate. The very initial part is not well shown. The first shaft is long and narrow, only 4 mm in H at its late portion. At the U-curved part shell is decreased in H, leaving a semi-perforation inside the U. The first and the second shafts are about to be contiguous with a very narrow interspace. The former has prorsiradiate ribs and constrictions.

The ribs on the second shaft are nearly transverse, rather weak and separated by somewhat wider interspaces, but there is some irregularity in their strength and their distance. They are slightly prorsiradiate on the late part of the second shaft, i.e. a part of the body-chamber. The short third arm, the rest of the body-chamber, has ribs of moderate intensity. The body-chamber is somewhat higher than broad.

Comparison:–This specimen is rather small. There is, however, size variation in *P. pseudogaultinum*. Three specimens in one and the same nodule from the Santonian of the Habora area (Matsumoto & Nihongi, 1979, fig. 1) measure about 141 mm, 131 mm and 123 mm in length. In comparison with them this specimen is unusually smaller (about 80 mm in length). The difference may imply a change with geological age or due to some ecological conditions or otherwise. We need more material to lead a conclusion.

In the well preserved three specimens from Haboro the cross-section of the shell is circular at every growth-stage with B/H = 1.0 or nearly 1.0. Yokoyama illustrated circular cross-sections of the probably septate parts of the two syntypes but thickly elliptical section (B/H = 0.95) of the late part of the second shaft. The present specimen may be rather unusual in showing B/H = 0.86 in its late growth-stage, but it is regarded provisionally as an extreme variant until more specimens are obtained.

Occurrence:–Rarely found at loc. T5011 (Uttsu) in the Zone of *M. subtilistriatum* of the Teshio Mountains. The species is common in the Santonian of various areas of Hokkaido and ranges up to the Campanian.

Genus *Diplomoceras* Hyatt, 1900

Type species:–*Hamites cylindraceum* Defrance ex. d'Orbigny, 1841.

Remarks:–See Part 2 (p. 68) for the general account of the genus.

Diplomoceras notabile Whiteaves, 1903
Pl. 8, Fig. 3

Synonymy:–See Part 2.

Material:–GK. H5968 collected by A. Tomita from loc. E42 of the Wembets-Rubeshbe and donated to Kyushu University through T. Matsumoto.

Description:–This is a single small specimen which probably represents comparatively early growth-stages of a *Diplomoceras* species. Comparing it with still smaller specimens from the Soya area (to be described in Part 2), the smooth first shaft is missing. The second shaft is very gently arcuate or nearly straight and connected by a broad U to the parallel and straight third shaft, which in turn is recurved by way of another U to the somewhat obliquely extending fourth shaft. The obliquity is at first about 30° but gradually decreased by a gently arcuate curvature of the shaft.

The length of the third shaft between the two Us is 24 mm and the breadth of the shell demarcated by the second and the third shafts are 10.4 mm. H = 2.2 mm at the beginning of the third shaft; H = 5.2 mm, B = 4.7 mm, B/H = 1.11 at the preserved end of the fourth shaft, which shows an elliptical cross-section.

The shell is ornamented by numerous, dense, annular ribs, which are nearly perpendicular to the axis of growth and weakly prorsiradiate on a part of the third shaft.

Suture seen on the preserved late part is fairly florid despite the small size of the shell.

Comparison and discussion:–This specimen is much smaller than the hitherto described specimens of *Diplomoceras*. There are, however, examples of *D. notabile* Whiteaves, 1903 from the Soya area, where large and small specimens occur in the same bed. This specimen is identified with them to the same species. It is quite similar to the larger specimens in its outline of cross-section and the mode of ribbing.

In the hitherto described larger shells of *D. notabile*, the two shafts connected by a U curve are not always exactly parallel but sometimes somewhat oblique (see Usher, 1952, pl. 40, fig. 1; Matsumoto & Morozumi, 1980, pl. 16, fig. 3). Therefore, the obliquity of the fourth shaft in the described small specimen would not be an objection against the identification.

For further discussion of the species see Part 2.

Occurrence:–Loc. E42 of the Wembets-Rubeshbe in the Zone of *Metaplacenticeras subtilistriatum*.

Subfamily Nostoceratinae Hyatt, 1894
Genus *Parasolenoceras* Collignon, 1969

Type species:–*Parasolenoceras splendens* Collignon, 1969 (original designation).

Remarks:–Klinger (1976) regarded *Parasolenoceras* as a subgenus of *Pseudoxybelоceras* Wright et Matsumoto, 1954. This could be acceptable (see Matsumoto & Morozumi, 1980, p. 19), but the former has a pair of ventral tubercles alone, without lateral tubercles, on every rib, whereas the latter has ventrolateral and ventral tubercles on every rib. The better developed I, as opposed to the reduced I, in the suture may be another distinction. On these grounds and also for brevity *Parasolenoceras* is treated as an independent genus in this paper.

Parasolenoceras tomitai sp. nov.

Pl. 8, Figs. 1–2

Material:–Holotype, GK. H5968, collected by A. Tomita at loc. E42 of the Wembets-Rubeshibe and donated to Kyushu University through T. Matsumoto.

Description:–The specimen consists of a broadly U curved part (A) and a fragmentary piece of a smaller straight shaft (B).

The shell is compressed with H = 9.2 mm, B = 7.2 mm, B/H = 0.78 at the posterior part of A and H = 11.5 mm, B = 8.5 mm, B/H = 0.74 at the preserved anterior end, subelliptical in corss-section, with angulations between the flat venter and the weakly convex flanks. The dorsum is narrowly arched.

The shell is ornamented with numerous simple ribs which are somewhat prorsiradiate on the flank and cross the venter vertically. They are separated by interspaces which are as narrow as the ribs. Every rib has a pair of ventral tubercles on the margins of the flat venter.

The suture is florid. L and the saddles E/L and L/U are large and expanding. I is tripartite and as long as the saddle I/U.

Comparison and discussion:–This specimen is allied to the holotype of *Parasolenoceras splendens* Collignon (1969, p. 46, pl. 530, fig. 2087), from the Lower Campanian of Madagascar, but it has a broader U, more compressed shell and more distinctly prorsiradiate ribs.

It is similar to the holotype of *Pseudoxybeloceras compressum* Henderson, 1970 (p. 31, pl. 4, fig. 4), from the Campanian of New Zealand, in the compressed shell-form and the numerous prorsiradiate ribbing, but in the New Zealand specimen the tubercles are periodically stronger than others. Likewise, it is similar to the holotype and paratypes of *Pseudoxybeloceras* (*Cyphoceras*) *nanimoense* Ward et Mallory, 1977 (p. 615, pl. 2, figs. 1–3; pl. 3, figs. 1–4), from the Campanian of Vancouver Island (Canada) but in that species U curve is narrower and the tubercles are periodically stronger extending to long spines. In my opinion, *P. compressum* and *P.* (*C.*) *nanimoense* could be of identical species and it would be better to assign them to *Parasolenoceras*.

The described specimen somewhat resembles the illustrated specimen of *Hamites interruptus* Schlüter, 1872 (p. 105, pl. 32, figs. 8, 9), probably from the *Mucronata* beds of Germany, but the latter is not so compressed as the former and has coarser ribs which are much weakened and almost smoothed on the venter. Anyhow, *H. interruptus* should be transferred to *Parasolenoceras*, as Klinger (1976, p. 76) has already suggested.

To sum up, this specimen certainly represents a new species of *Parasolenoceras*, although more material is needed to give a well defined diagnosis.

Occurrence:–Rarely found at loc. E42, Wembets-Rubeshbe, from the Zone of *Metaplacenticeras subtilistriatum*.

Some Ammonites from the Campanian (Upper Cretaceous) of Northern Hokkaido

Plates

Plates 1 – 9

Part 1 (Teshio Mountains by T. Matsumoto)

Photos by courtesy of Dr. Masayuki Noda

Plate 1

Explanation of Plate 1

Fig. 1. *Neophylloceras ramosum* (Meek) . . . . . Page 9
GK. H5942 from loc. E33, Webets-Rubeshbe, T. Matsumoto Coll. Lateral (a), ventral (b) and frontal (c) views, x 1.

Fig. 2. *Desmophyllites diphylloides* (Forbes) . . . . . Page 12
GK. H5962 from Wembets-Rubeshbe, A. Tomita Coll. Two lateral (a, b), ventral (c) and frontal (d) views of an immature shell, x 1.75.

Fig. 3. *Neophylloceras* cf. *N. nera* (Forbes) . . . . . Page 10
GK. H5943 from loc. E33, Wembets-Rubeshbe, T. Matsumoto Coll. Lateral view, x 1.5.

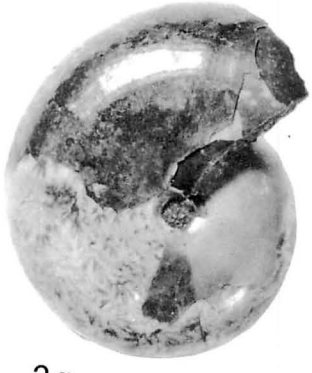
Figs. 4–5. *Neophylloceras hetonaiense* Matsumoto . . . . . Page 11

4. GK. H5955 from Wembets-Rubeshbe, A. Tomita Coll. Ventral (a) and lateral (b) views of an immature example, x 1.5.
5. GK. H5957 from Abeshinai-Rubeshbe, T. Muramoto Coll. Lateral view of a still younger example, x 3.

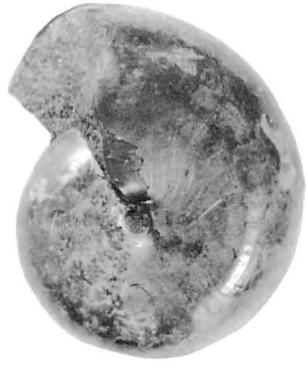
1a

1b

1c



2a



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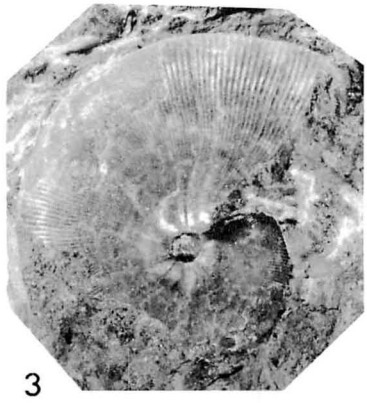
2c

2d



3

4a

4b

5

T. Matsumoto: Teshio Mountains

Plate 2

Explanation of Plate 2

Figs. 1–2. *Mesopuzosia densicostata* Matsumoto . . . . . Page 13

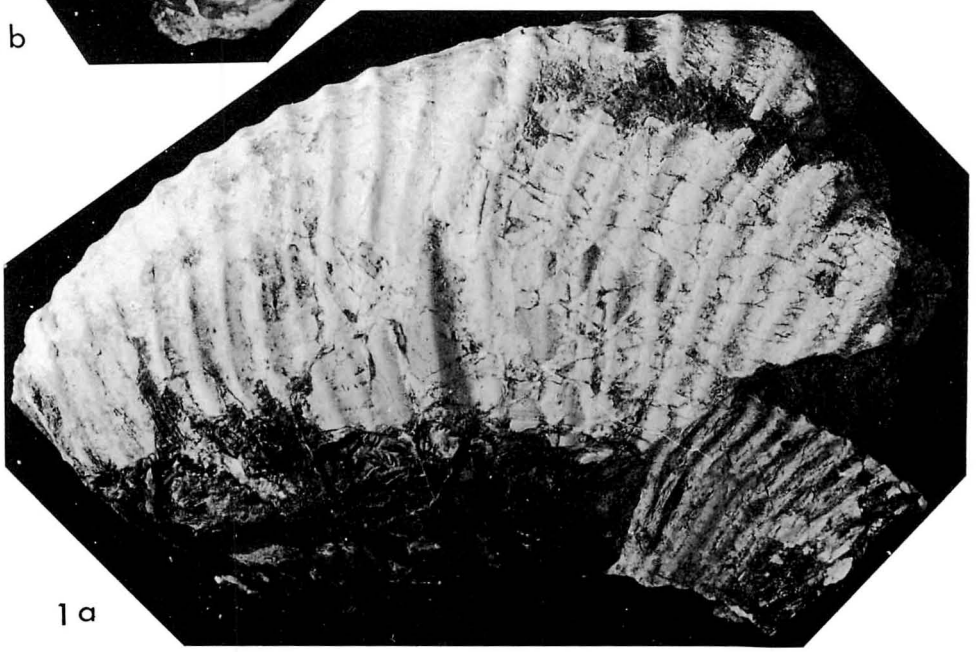
1. GK. H5965 from loc. T5011, Uttsu, Masafumi Nihongi & T. Matsumoto Coll. Lateral (a) and ventral (b) views, x 1.
2. A smaller example from loc. T5011, Uttsu in the Collection of Takanobu Nishino. Lateral (a), ventral (b) and frontal (c) views, x 2.

1b

2b

2a

2c



1a

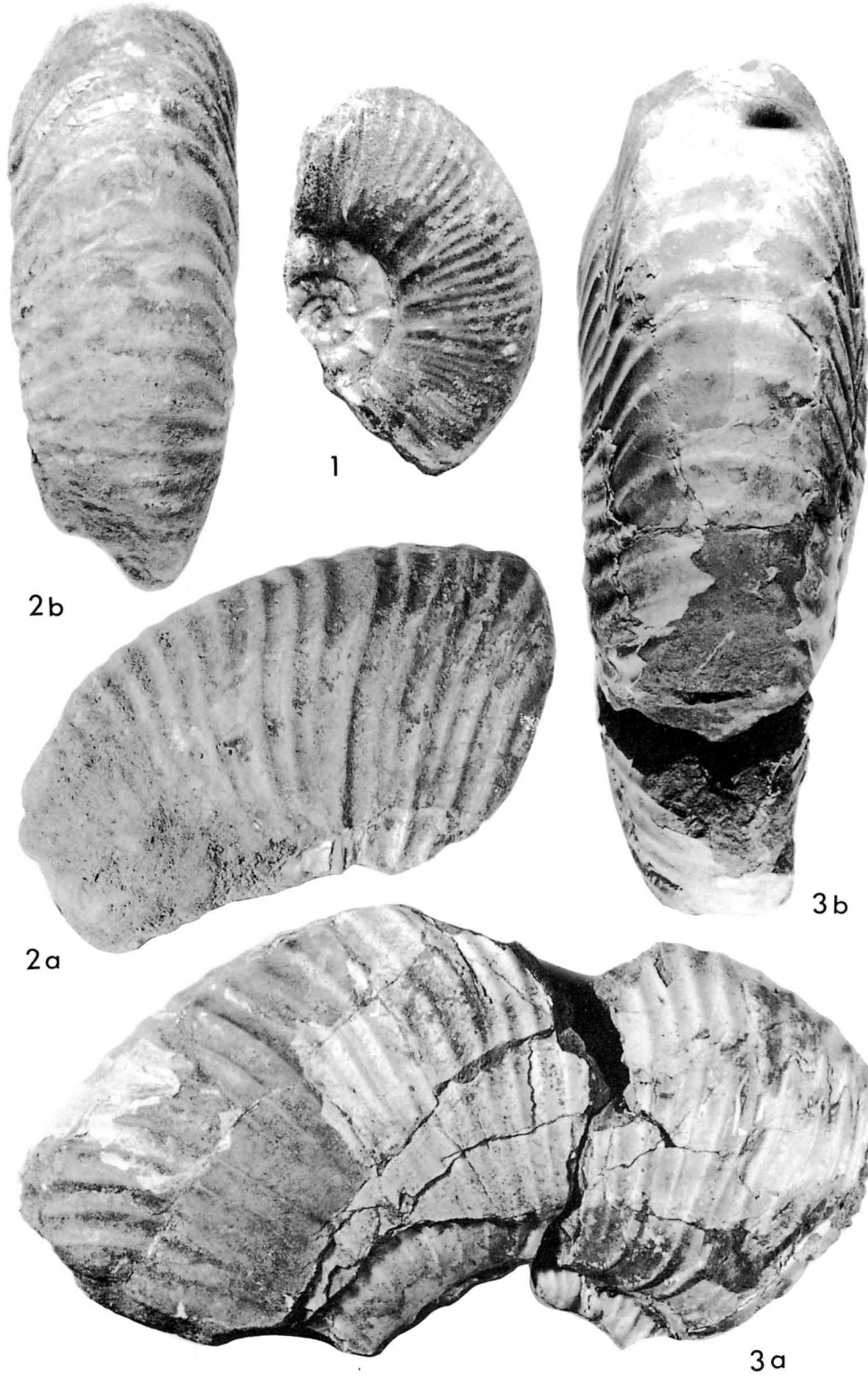
T. Matsumoto: Teshio Mountains

Plate 3

Explanation of Plate 3

Figs. 1–3. *Canadoceras multicostatum* Matsumoto . . . . . Page 18

1. An immature example in the Collection of T. Nishino from loc. T5011, Uttsu. Lateral view, x 2.
2. GK. H5935, from loc. E42, Wembets-Rubeshbe, T. Matsumoto Coll. Lateral (a) and ventral (b) views of a fragmentary whorl of middle growth-stage, x 1.
3. GK. H5934, from loc. E42, Wembets-Rubeshbe, T. Matsumoto Coll. Lateral (a) and ventral (b) views, x 2/3.



T. Matsumoto: Teshio Mountains

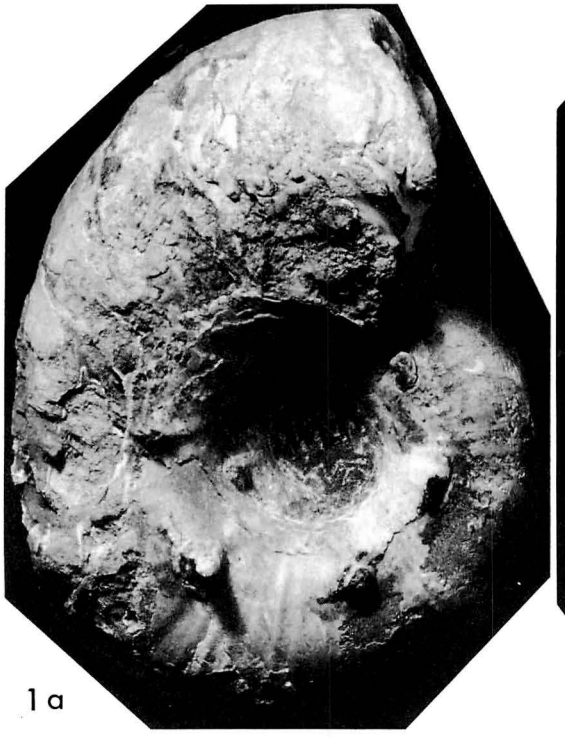
Plate 4

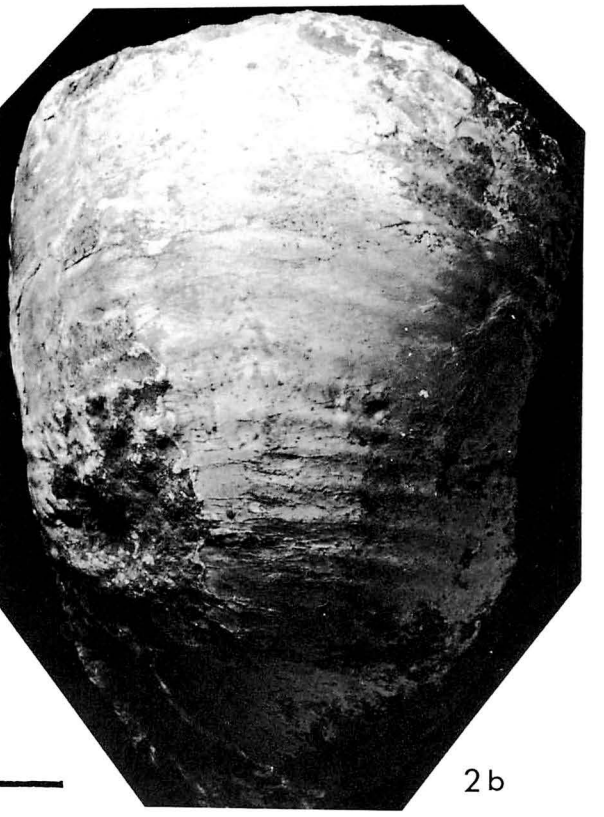
Explanation of Plate 4

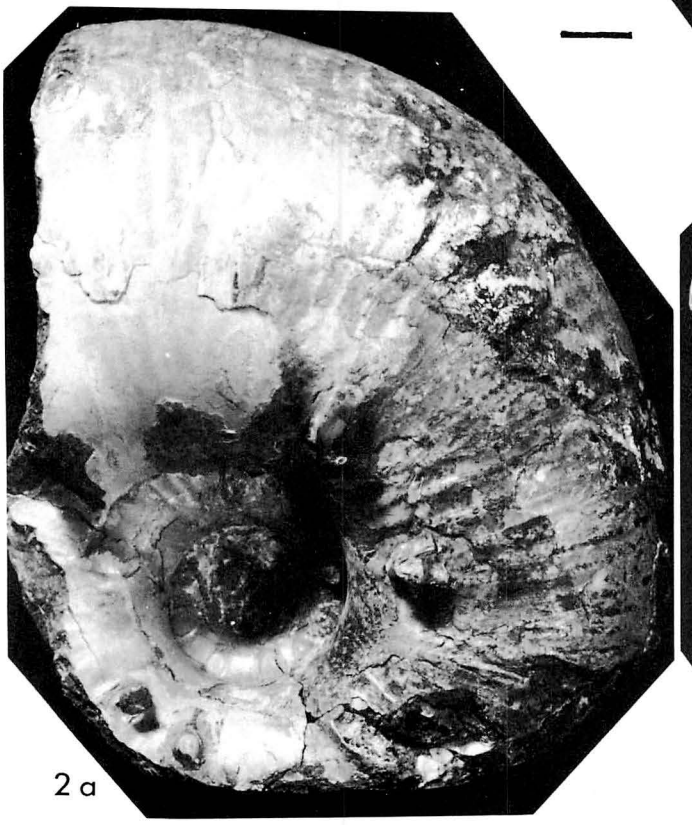
Figs. 1–2. *Anapachydiscus fascicostatus* (Yabe) . . . . . Page 14

1. GK. H5936 from loc, E45, Wembets-Rubeshbe, M. Yamashita Coll. (6409). Lateral (a) and frontal (b) views, x 1.
2. GK. H5937 from loc. E45, Wembets-Rubeshbe, M. Yamashita Coll. (5510). Lateral (a) and ventral (b) veiws, x 0.9.

Scale bar = 10 mm







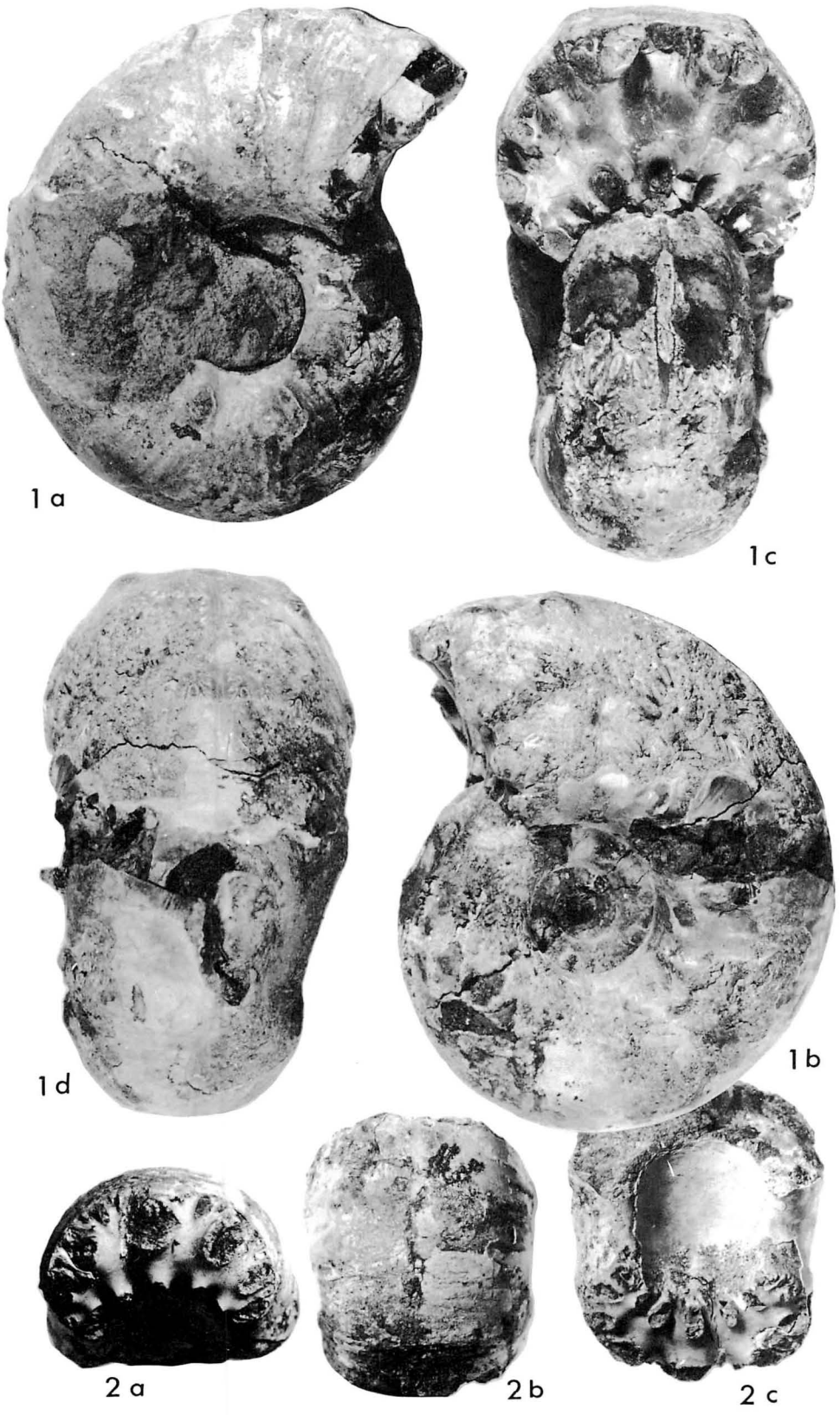
T. Matsumoto: Teshio Mountains

Plate 5

Explanation of Plate 5

Fig. 1. *Menuites sanadai* Matsumoto, sp. nov. . . . . Page 17
Holotype, GK. H5969 from loc. T5011, Uttsu, K. Sanada Coll. (460616). Two lateral (a, b), frontal (c) and ventral (d) views, x 1.

Fig. 2. *Anapachydiscus fascicostatus* (Yabe) . . . . . Page 14
GK. H5938 from loc. T5011, Uttsu, T. Matsumoto Coll. Back (a), ventral (b) and dorsal (c) views, x 1.



T. Matsumoto: Teshio Mountains

Plate 6

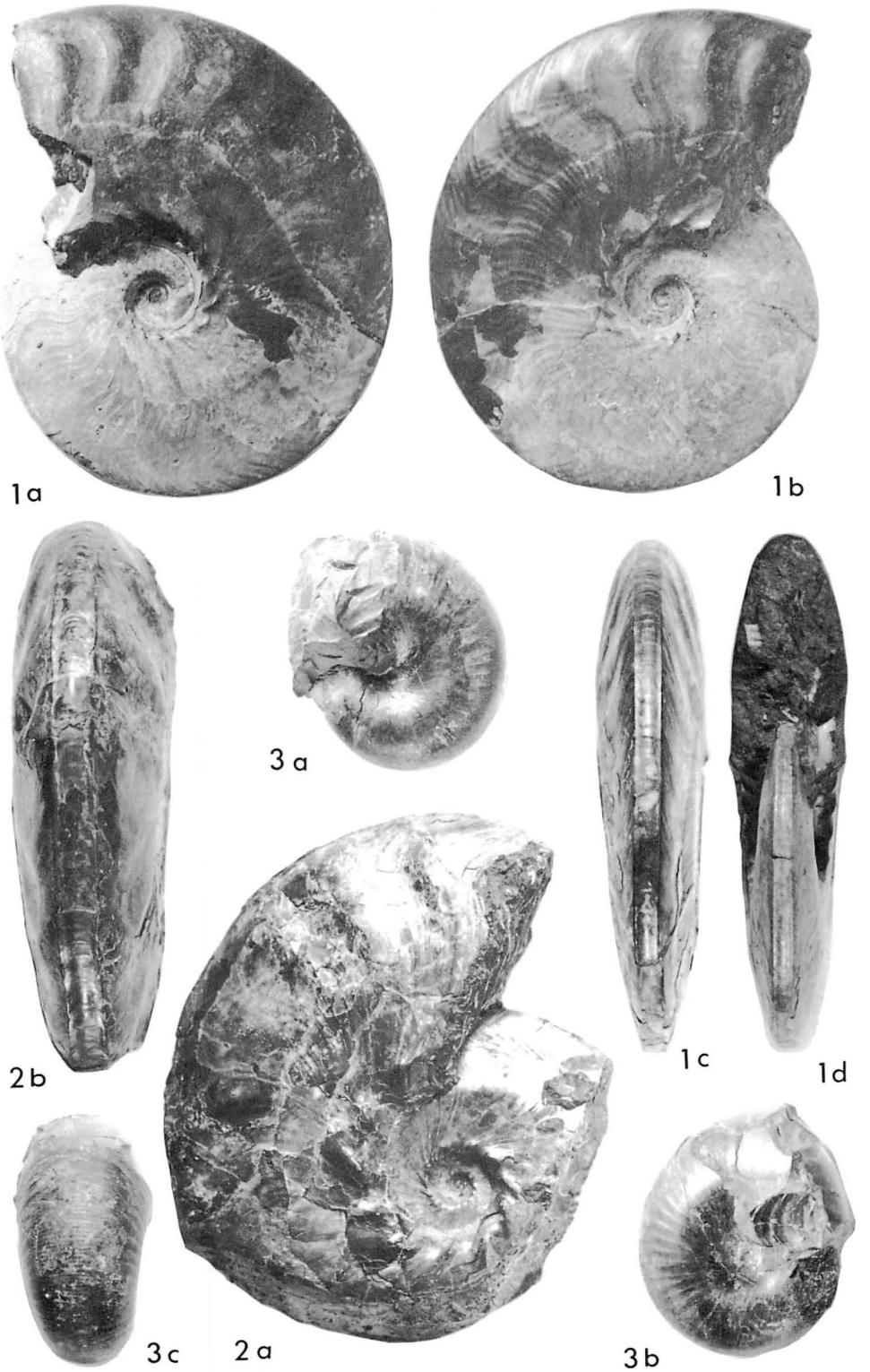
Explanation of Plate 6

Figs. 1–2. *Metaplacenticeras subtilistriatum* (Jimbo) . . . . . Page 21

1. TTC. 410817 from the Tan-no-sawa, T. Takahashi Coll. Two lateral (a, b), ventral (c) and frontal (d) views, x 1.
2. TTC. 480814 from Wembets-Rubeshbe, T. Takahashi Coll. Lateral (a) and ventral (b) views, x 1.

Fig. 3. *Phyllopachyceras ezoense* (Yokoyama) . . . . . Page 39

GK. H3022 from loc. U147-2, Bed Ur2β, Santonian of Urakawa area, T. Matsumoto Coll. Two lateral (a, b) and ventral (c) views, x 1.



T. Matsumoto: Teshio Mountains

Plate 7

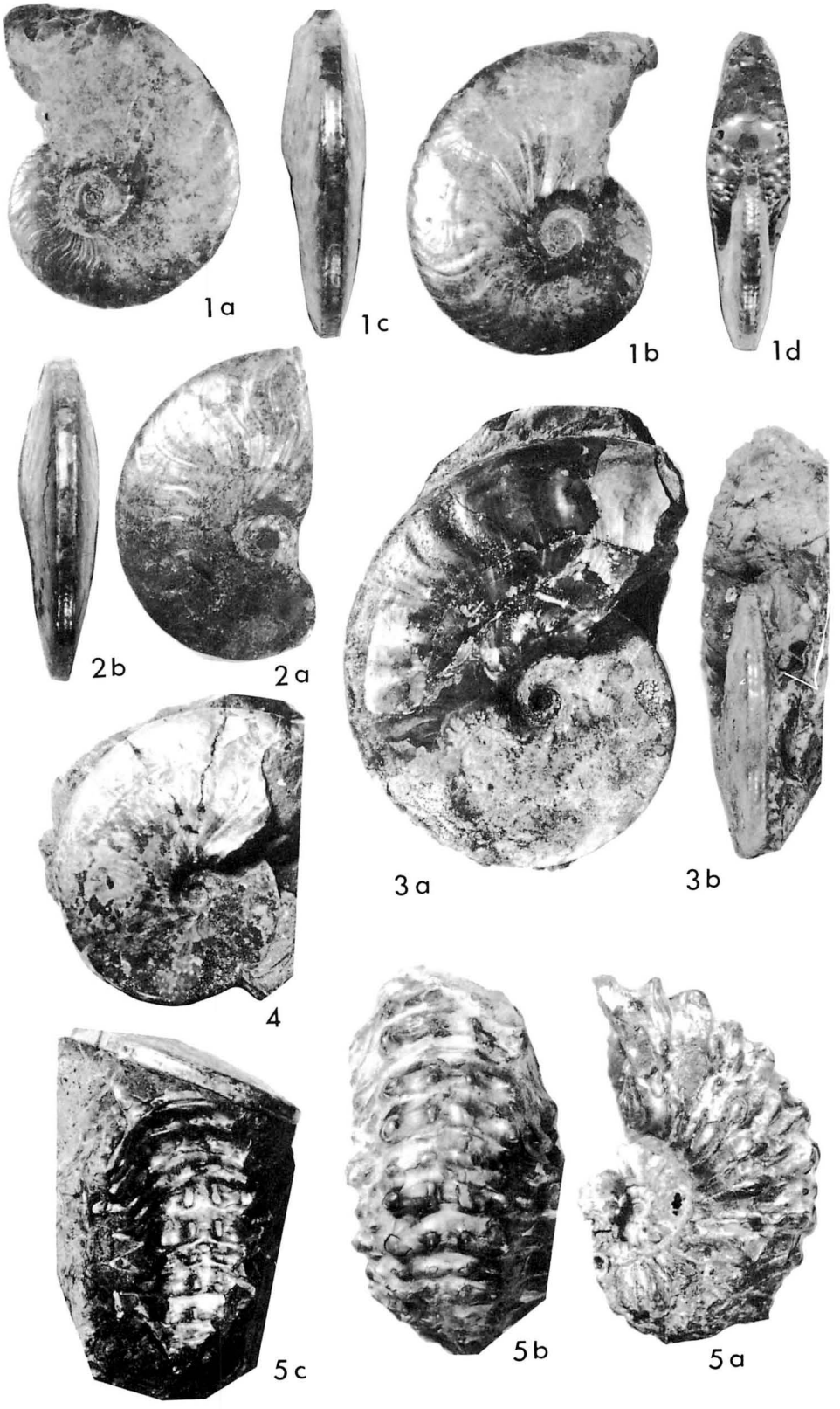
Explanation of Plate 7

Figs. 1–4. *Metaplacenticeras subtilistriatum* (Jimbo) . . . . . Page 21

1. GK. H5946 from loc. E33, Wembets-Rubeshbe, M. Yamashita & T. Matsumoto Coll. Two lateral (a, b), ventral (c) and frontal (d) views of an immature example, approximately x 2.
2. GK. H5945 from loc. E33, Wembets-Rubeshbe, M. Yamashita & T. Matsumoto Coll. Lateral (a) and ventral (b) views of an immature example, x 1.5.
3. GK. H5947 from loc. E42, Wembets-Rubeshbe, M. Yamashita & T. Matsumoto Coll. Lateral (a) and frontal (b) views of an adult example, x 1.
4. GK. H5948 from loc. E33, Wembets-Rubeshbe, M. Yamashita Coll. Lateral view, x 1.1. See Fig. 5 (c) top for the ventral view.

Fig. 5. *Hoplitoplacenticeras monju* Matsumoto . . . . . Page 24

Holotype, GK. H5959, from loc. E33, M. Yamashita Coll. Lateral (a) and ventral (b) views, x 4/3; external mould of the venter (c), x 1.1.



T. Matsumoto: Teshio Mountains

Plate 8

Explanation of Plate 8

Figs. 1–2. *Parasolenoceras tomitai* Matsumoto, sp. nov. . . . . Page 32

1. Holotype, GK. H5968A, from loc, E42, Wembets-Rubeshbe, A. Tomita Coll. Two lateral (a, b) and ventral (c) views, x 1.5.
2. GK. H5968B, detached portion of the same individual. Lateral view (a) and cross-section and another fragmentary piece (b), x 1.5.

Fig. 3. *Diplomoceras notabile* Whiteaves . . . . . Page 31

GK. H5967, from loc. E42, Wembets-Rubeshbe, A. Tomita Coll. Lateral view of an immature shell, x 1.5.

Fig. 4. *Polyptychoceras pseudogaultinum* (Yokoyama) . . . . . Page 29

Y. N. 2 from loc. T5011, Uttsu, private collection of Yasunori Nakaya. Lateral view, x 1.1.

Fig. 5. *Hoplitoplacenticeras fugen* Matsumoto, sp. nov. . . . . Page 25

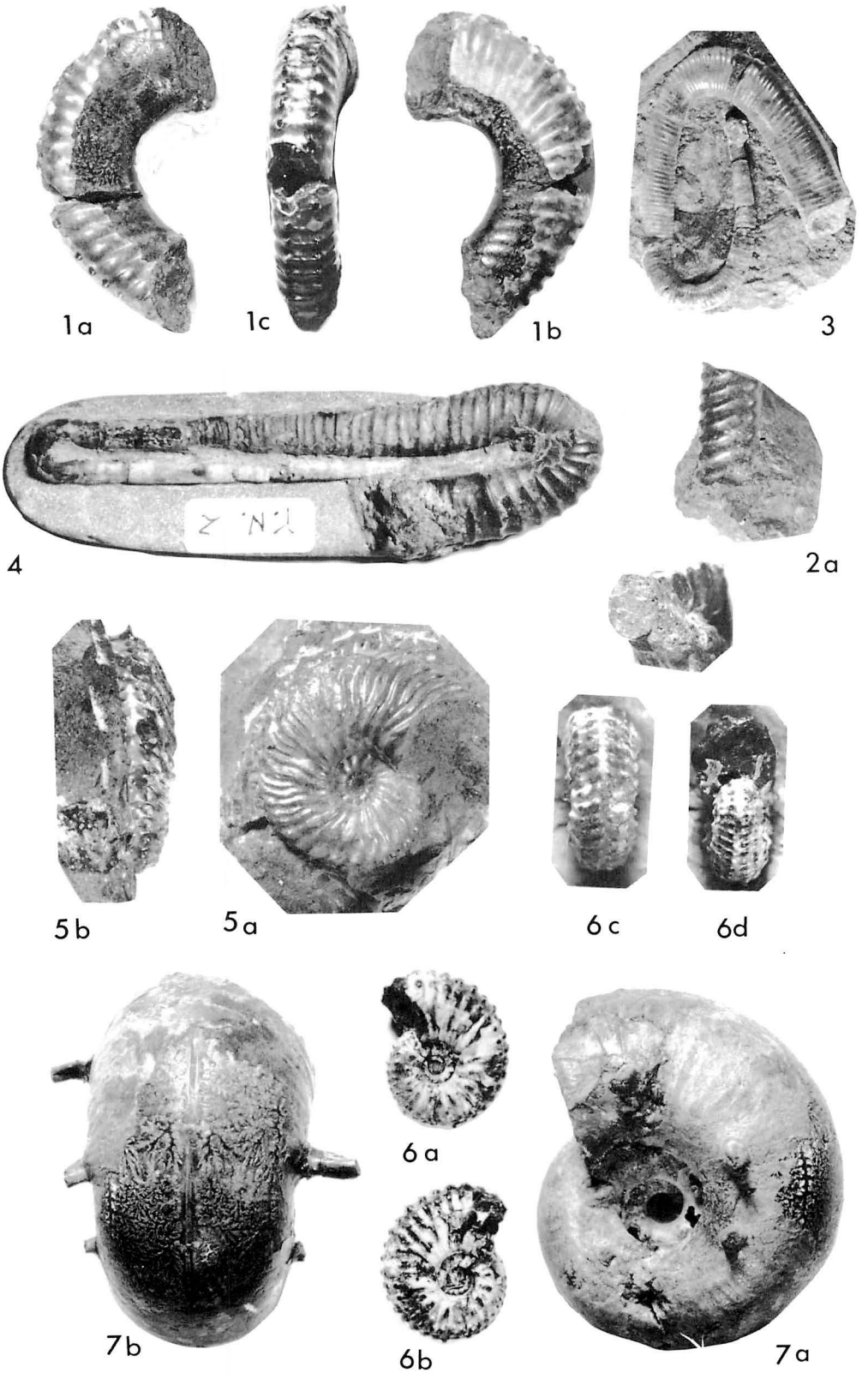
Holotype, GK. H5960, from loc. E33, Wembets-Rubeshbe, A. Tomita Coll. Lateral (a) and ventral (b) views, x 1.75.

Fig. 6. *Hoplitoplacenticeras monju* Matsumoto . . . . . Page 24

Paratype, GK. H5966, from Tan-no-sawa, Y. Kawashita Coll. Two lateral (a, b), ventral (c) and frontal (d) views of an immature shell, x 3.

Fig. 7. *Anapachydiscus fascicostatus* (Yabe) . . . . . Page 14

TTC. 460615 from loc. T5011, Uttsu, T. Takahashi Coll. Lateral (a) and ventral (b) views of an immature example, x 1.



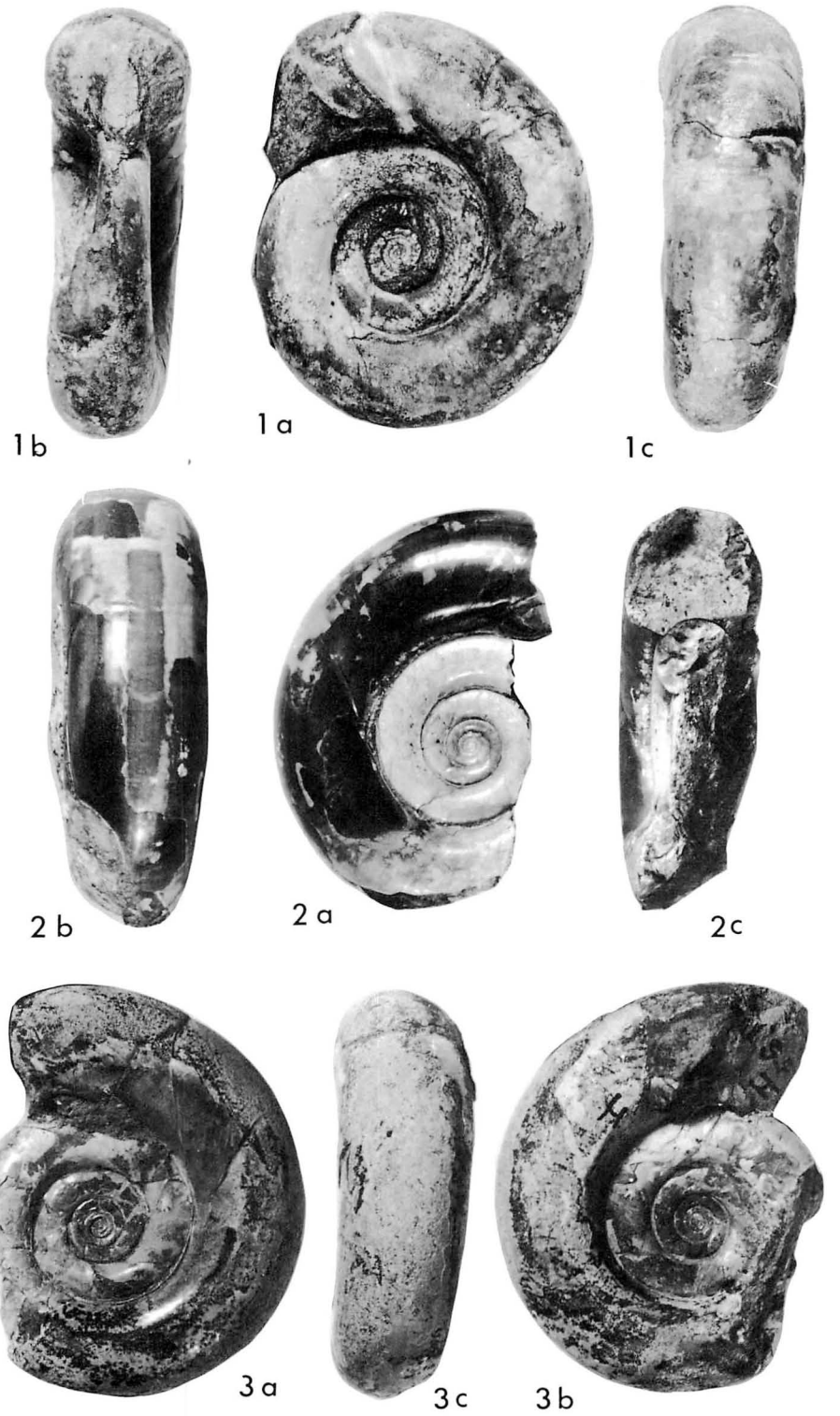
T. Matsumoto: Teshio Mountains

Plate 9

Explanation of Plate 9

Figs. 1–3. *Saghalinites teshioensis* Matsumoto, sp. nov. . . . . Page 27

1. Holotype, GK. H5971 (K. Sanada Coll. 460116), from loc. T5011, Uttsu. Lateral (a), ventral (b) and frontal (c) views, x 1.
2. Paratype, GK. H5939 (A. Tomita Coll. 520925), from Wembets-Rubeshbe. Lateral (a), ventral (b) and frontal (c) views, x 1.
3. Paratype, GK. H5941 (M. Yamashita Coll. 5510), from loc. E45, Wembets-Rubeshbe. Two lateral (a, b) and ventral (c) views, x 1.



T. Matsumoto: Teshio Mountains

PART II. SOME CAMPANIAN AMMONITES FROM THE SOYA AREA

By

T. MATSUMOTO and T. MIYAUCHI

(Studies of the Cretaceous Ammonites from Hokkaido–LI)

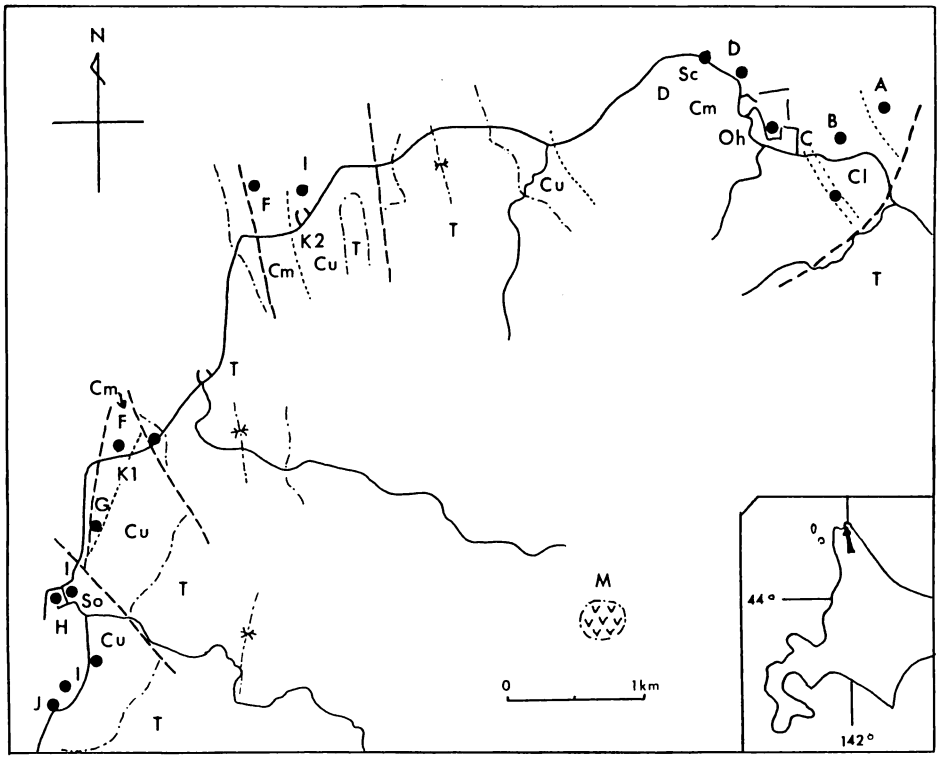
Notes on Stratigraphy

Cape Soya occupies the northernmost part of Hokkaido and now belongs administratively to the eastern part of the City of Wakkanai. Geologically the area is made up primarily of Cretaceous and Tertiary strata, besides small bodies of basaltic rock and Quaternary terrace deposits at several levels. According to previous works (Osanai *et al.*, 1959; Matsumoto & Obara, 1971), the Cretaceous strata are overlain by the Tertiary (Miocene) Magaribuchi Formation with an unconformity of a considerable time-gap. The strata of the Cretaceous and the Tertiary are folded and faulted together, without distinct structural gap between the two groups of strata.

The Cretaceous strata exposed on the eastern coast of Cape Soya show fairly complicated geologic structures and seem to range in age from Upper Albian (?) to Campanian. Although some interesting fossils occur in this eastern part, there is so far no species which indicates the Upper Campanian. Those exposed in the northernmost part, called Ohmisaki, and in the western coastal area of the cape, including the fishery harbours of Soya, Kiyohama-I [=Dai-ichi Kiyohama] and Kiyohama-II [=Dai-ni Kiyohama, that is Orannai in older maps] are mostly referred to the Campanian. They show rather gentle inclinations, but there is repetition or omission of strata by the faults of N-S and NW-SE trends (Text-fig. 6). The Maastrichtian is lacking in the coastal area but a part of it crops out in the central hilly area between Koishi and Magaribuchi (further south from the mapped area), where Tertiary strata occupy a wider area. Therefore, the Campanian-Maastrichtian boundary is hardly examined in the area of Cape Soya.

The exposures of the strata in the western coastal area are unfavourable on the land side, but there is a wave cut bench to the extend of 100 m to about 500 m off the coast. That bench is usually submarine, but at the time of the lowest tide some parts of the bench are accessible for us to examine the constituting strata and to collect the contained fossils. There was, furthermore, a reconstruction of the fishery harbour of Soya completed in 1973. On that occasion one of us (T. Miyauchi) observed the temporarily exposed, otherwise submarine, strata at the excavated place and have collected fossils from the excavated blocks of rock brought to the coast.

Aside from the large scale excavation at the Soya harbour, dredging rock floor of the bench was frequently in operation near the coast for the passage of small fishery boasts. Fossils can be hunted from the dredged rock fragments.



Text-fig. 6. Geological outline map of the Soya area.
A-J: Members of the Cretaceous sequence described in the text, Cl: Lower Campanian, Cm: Middle Campanian (=upper Lower Campanian in the bipartite scheme), Cu: Upper Campanian, T: Tertiary (Miocene). Place names-K1: Kiyohama-I, K2: Kiyohama-II, M: Maru-yama, Oh: Ohimisaki, Sc: head of Cape Soya, So: Soya harbour. •: Representative fossil locality, v: Basalt

Under these circumstances field works have been done intermittently for years by T. Miyauchi and his friends. Since 1974 T. Matsumoto has conducted the work on the grounds of biostratigraphy, examining the outcrops every summer.

Through these procedures, the biostratigraphic sequence in the northwestern coastal area of Cape Soya has been made clear as follows in ascending order (see also Text-fig. 7):

A. Mudstone containing calcareous nodules at loc. W4A, off the east coast of Ohmisaki, at least 50 m. *Eupachydiscus haradai* (Jimbo) occurs here characteristically.

B. Mudstone with some sandy laminae at loc. W4A, closer to the coast. *Sphenoceramus orientalis* (Sokolow), *S. elegans* (Sokolow) and *Anapachydiscus* (*Neopachydiscus*) *naumanni* (Yokoyama) are characteristic.

C. Medium- to coarse-grained, cross-bedded sandstone, 8 m thick, exposed on the back of Ohmisaki Primary School and extended northwestward to a part of the wave cut bench of W4B. *Sphenoceramus schmidti* (Michael) occurs in certain layers.

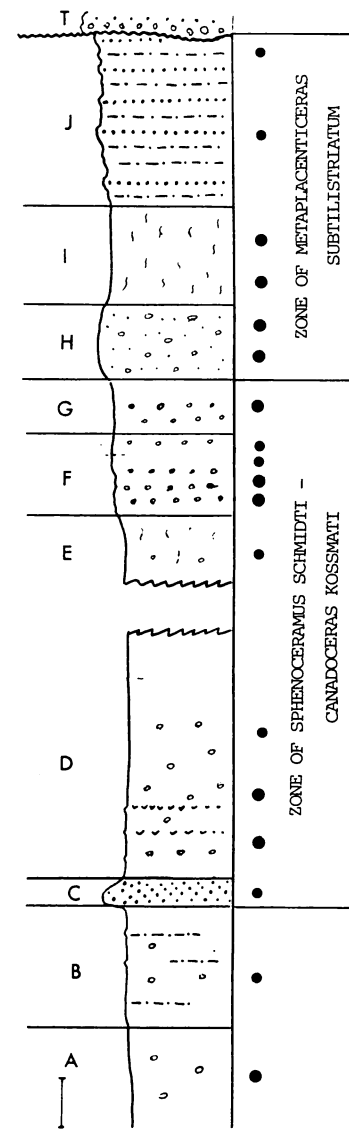
D. Mudstone, with subordinate sandstone, typically exposed at the head of the cape including the wave cut bench of W4B (main part) and W4C, at least 250 m in thickness, characterized by *S. schmidti Gigantocapulus giganteus* (Schmidt), *Canadoceras kossmati* Matsumoto, etc., which occur mostly in the contained calcareous nodules.

E. Some thickness of mudstone above D (less fossiliferous), exposed partly discontinuously.

F. Silty fine-grained sandstone or fine-sandy siltstone, about 30 m. In the contained calcareous nodules, drifted pieces of vegetable matter are accumulated along with some well preserved molluscan fossils. This unit is called the "*Fukiyose* Beds" or "*Fukiyose* Member" [*Fukiyose* in Japanese means drifted together] in our field work for convenience' sake. There are at least four beds which contain such nodules. This unit constitutes the wave cut bench off the coast of Kiyohama-I (W7C) and a part of the one off the western coast of Kiyohama-II (W7D). The characteristic species are *Canadoceras mysticum* Matsumoto, *C. minimum* sp. nov., *Baculites chicoensis yezoensis* subsp. nov. and *Eutrephoceras soyaense* Matsumoto et Miyauchi, among many others. *Sphenoceramus schmidti* occurs in the lower two beds of this unit, indicating the uppermost part of the Zone of *Sphenoceramus schmidti*. The thickness of this unit is at least 60 m.

G. Silty fine-grained sandstone to fine-sandy siltstone, often bioturbated. Fossils from this unit, exposed between Soya and Kiyohama-I, are much distorted owing to the deformation along a fault. They are mostly long-ranging species belonging to *Phyllopachyceras, Desmophyllites, Tetragonites* etc. No example of *Sphenoceramus schmidti* nor that of *Schlueterella kawadai* sp. nov. has been found.

H. Green silty fine-grained sandstone with some sandy siltstone. It contains a characteristic heteromorph ammonite, *Schlueterella kawadai* sp. nov. In addition, *Diplomoceras notabile* Whiteaves, *Baculites inornatus* Meek, *Pachydiscus soyaensis* sp. nov. and *Canadoceras mutlticostatum* Matsumoto are also characteristic, although some of them range upward and/or downward. *Metaplacenticeras* cf. *M. subtilistriatum* is occasionally found. Also *Gaudryceras mamiyai* sp. nov. and *Pachydiscus sahekii* sp. nov. are probably from this unit.



Text-fig. 7. Stratigraphic sequence of the Upper Cetaceous strata exposed on the coast of the Soya area. A-J: Members described in the text. Thickness of each member approximate. Scale bar: 20 m. •: Representative fossiliferous level.

The beds of this unit were exposed during the large scale excavation for the reconstruction of the Soya harbour (W7A, B). They are traced southward and northward to certain places in the wave cut bench. The thickness of the unit is at least 10 m, though hardly estimated with precision. The excavated blocks of rock from this unit, together with contained nodules were brought to the coast and numerous specimens

of fossils have been collected. Thus an interesting but hitherto little known faunule has been clarified.

I. Dark grey siltstone, sometimes sandy, containing rather sporadically remains of *Metaplacenticeras subtilistriatum* (Jimbo) and more rarely those of *Hoplitoplacenticeras* cf. *H. fugen* Matsumoto. As the fossils are not contained in calcareous nodules, they are rather poorly preserved.

On the occasion of excavating the Soya harbour, one of us (T. Miyauchi) observed this member below Member H. This unit was traced southward on land along the road (again during the operation of reconstructing a road shoulder). It also crops out on a shallower part of wave cut bench about 150 m off the coast line of Kiyohama-II. As the rock exposure is not complete the thickness of this unit is not precisely estimated but may be at least 20 m.

J. Sandstone and siltstone in alternation, forming well-defined beds of compact sandstone in some parts but may be intermingled in lenticular forms. Fossils occur only sparsely in which *Canadoceras multicostatum, Desmophyllites diphylloides, Metaplacenticeras* cf. *M. subtilistriatum* and *Anapachydiscus* cf. *A. fascicostatus* have been identified.

This unit, about 70 m in thickness at the minimum estimation, is exposed on the rocky coast between Soya and Tomiiso, and overlain by the Tertiary Magaribuchi Formation with an unconformity. The compact sandstone along the shoreline north of Soya up to northward elongated point of wave cut bench is probably assigned to this unit.

In the officially published geological map (Osanai *et al.*, 1959), the Upper Cretaceous strata in the northwestern part of Cape Soya are grouped into two formations, the Ohmisaki Formation below and the Orannai Formation above. Units A to E in our scheme are the major part of the Ohmisaki Formation and units F to J altogether are the Orannai Formation. Based on the concept of cycle of sedimentation, the above described units should be grouped into three formations; the lower one including units A and B, the middle one consisting of units C, D, E, F and probably G, and the upper one consisting of units H, I and J. The lower formation is unnamed and may include still underlying part, the middle should be called the Ohmisaki Formation in a revised sense, and the upper the Orannai Formation in a revised sense.

Biostratigraphically, unit B is assigned to the Zone of *Sphenoceramus orientalis*, which represents Substage K6a1 on the Japanese scale, approximately Lower Campanian in terms of the international scale (indicated as Cl in Text-fig. 6). Whether Member A is the lowest part of the Campanian or the uppermost part of the Santonian or otherwise is hardly decided on the available evidence. Members C to F are assigned to the Zone of *Sphenoceramus schmidti-Canadoceras kossmati*, which represents Substage K6a2 on the Japanese scale, approximately Middle Campanian (=upper Lower Campanian in the bipartite scheme), and Members H, I and J can be defined as the Zone of *Metaplacenticeras subtilistriatum*, which represents Substage K6a3, approximately Upper Campanian. Further details will be discussed in the concluding remarks.

The systematic descriptions below concern primarily with the species from the Zone of *M. subtilistriatum* and include some of the interesting species from the underlying Zone of *Sphenoceramus schmidti*.

Systematic Descriptions

Order Ammonitida Agassiz, 1847
Suborder Phylloceratina Arkell, 1950
Family Phylloceratidae Zittel, 1884
Genus *Neophylloceras* Shimizu, 1934

See Part 1 (p. 8) for the general account of the genus.

Neophylloceras ramosum (Meek, 1858)

Pl. 10, Fig. 5

Synonymy:–See Part 1 (p. 9).

Material:–MNH. 198 and some others from the Fukiyose Bed of Kiyohama-I, MNH. 199 from W4B, Ohmisaki, collected by T. Miyauchi.

Dimensions:–

Specimen	D	U	H	B	B/H
MNH. 198	70.0 (1)	4.6 (.07)	40.4 (.58)	21.4 (.31)	0.53
MNH. 199	37.5 (1)	2.4 (.06)	22.9 (.61)	12.0 (.32)	0.52

Descriptive remarks:–These specimens show the same diagnosis as those described in Part 1.

Occurrence:–Not uncommon in the Fukiyose Bed, upper part of the Zone of *Spheno-ceramus schmidti*, at Kiyohama-I; also in the lower part of the same zone at Ohmisaki.

Neophylloceras sp. nov. aff. *N. ramosum* (Meek, 1858)

Pl. 10, Fig. 2; Pl. 23, Fig. 1

Material:–MNH. 197 and larger but incomplete MNH. 500, collected by T. Miyauchi from the Fukiyose Member of Kiyohama-I.

Description:–These are wholly septate. The whorl is higher than broad, and broadest somewhat below the mid-flank in the lower part, with gradual and then rapid sloping down into a very narrow umbilicus. Flanks are rather flat, and slightly convergent upward to a narrowly arched venter.

Radial lirae are somewhat flexuous; that is radial on the steep umbilical wall, prorsiradiate on the dorsal flank, gradually bent at about the point of the maximum breadth, to become radial on the main part of the flank and very gently curved forward at about the ventrolateral part, crossing the venter nearly radially. About 40 lirae are counted on the venter for 45° in the larger specimen and 30 in the smaller one.

The suture is of typical *Neophylloceras* pattern.

Dimensions:–

Specimen	D	U	H	B	B/H
MNH. 197	41.3 (1)	2.9 (.07)	23.4 (.57)	15.6 (.38)	0.66
MNH. 500	63 (1)	7 (.11)	37.0 (.58)	22.5 (.36)	0.61

Comparison:–These are examples of an undescribed, probably new species which is represented by several better preserved specimens from the Upper Cretaceous (probably Santonian) of the Ikushumbets area (central Hokkaido). It is similar to *N. ramosum* (Meek) (see p. 9 of this paper), but is somewhat less compressed, broader in the lower part of the whorl, and its lirae are not so dense nor so distinctly flexuous as in the latter.

Occurrence:–Rare in the Fukiyose Member of the Soya area. The record is noted in that it marks probably the upper limit of this unnamed new species.

Neophylloceras hetonaiense Matsumoto, 1942

Pl. 10, Fig. 1

Synonymy:–See Part 1 (p. 11).

Material:–MNH. 196 from the Fukiyose Bed of Kiyohama-I, collected by T. Miyauchi.

Dimensions:–

Specimen	D	U	H	B	B/H
MNH. 196	30.6 (1)	2.6 (.08)	18.0 (.59)	9.8 (.32)	0.54

Descriptive remarks:–This small, probably immature shell shows well the characteristic features of *N. hetonaiense* (see Part 1). It has bullate weak umbilical nodes, which are often discernible on the immature shells from the type Hetonai (now called Tomiuchi) area. The lirae are less flexuous than those of *N. ramosum*. About 80 lirae are counted within a quarter whorl (90°) of this small specimen.

Occurrence:–Rarely found in the Fukiyose Member of Kiyohama-I, upper part of the Zone of *Sphenoceramus schmidti*. This is the earliest record of unmistakable example of *N. hetonaiense*.

Genus *Phyllopachyceras* Spath, 1926

Type species:–*Ammonites infundibulum* d'Orbigny, 1841 (original designation).

Remarks:–This genus could be regarded as a synonym of *Partschiceras* Fucini, 1920, as was stressed by Wiedmann, whom Kennedy & Klinger (1977a) followed. We would not, however, disregard the sutural pattern in the Phylloceratidae and should like to distinguish them in that the first and the second lateral saddles in the late growth-stage is diphyllic in *Partschiceras* and tetraphyllic in *Phyllopachyceras*. The geological range of *Phyllopachyceras* considerably overlaps with that of *Partschiceras* but extends later.

Phyllopachyceras ezoense (Yokoyama, 1890)

Pl. 10, Figs. 3–4

1890. *Phylloceras ezoensis* Yokoyama, *Palaeontographica*, vol. 36, p. 178, pl. 19, fig. 2.
1921. *Phylloceras ezoense* Yokoyama; Yabe & Shimizu, *Sci. Rep. Tohoku Imp. Univ.*, 2nd ser. vol. 5, no. 3, p. 54, pl. 8, fig. 2.
1942. *Phyllopachyceras ezoense* (Yokoyama); Matsumoto, *Proc. Imp. Acad.* Tokyo, vol. 18, p. 674.
1955. *Phyllopachyceras ezoense* (Yokoyama); Matsumoto & Obata, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 5, no. 3, pl. 30, fig. 3.

Material:–MNH. 213 collected by T. Saheki and MNH. 200 collected by T. Miyauchi from Kiyohama-I. Many other smaller specimens.

Dimensions:–

Specimen	D	U	H	B	B/H
MNH. 213	64.6 (1)	1.3 (.02)	37.0 (.57)	34.0 (.53)	0.98
" (–90°)	52.0 (1)	1.1 (.02)	30.8 (.59)	29.5 (.57)	0.96
" (–270°)*	–	–	19.5	19.5	1.00
GK. H3022*	38.0 (1)	1.0 (.03)	19.4	19.4	1.00

*at the last septum.

Diagnosis:–Shell rather small, below 75 mm in diameter at adult stage, highly involute. Expansion ratio fairly high. Septate whorl nearly as high as broad and subcircular in section. Body-chamber about 270° in length, slightly higher than broad and subcircular to thickly elliptical in section. Umbilicus very narrow and surrounded by inclined dorsal part of the flank, forming funnel shape. Apertural margin with ocural sinus on the umbilical slope and then gently flexiradiate on flank, crossing venter nearly radially.

Surface of shell with dense, blunt lirae separated by striae, which run nearly parallel to the apertural margin. Major ribs begin to appear in more or less late growth-stage on septate whorl as faint elevations and then gradually strengthened and coarsened on adult body-chamber, where they are fairly crowded, showing bifurcation or intercalation, and separated by narrower interspaces.

Suture as for the genus. Saddles on both sides of L tetraphyllic already in immature stage; incisions of elements moderately deep and fine in later stages; E nearly as deep as L.

Comparison and discussion:–The holotype (Yokoyama, 1890, pl. 19, fig. 2 by monotypy), from Urakawa, southern central Hokkaido, should be kept in Munich (München), but we have not seen it. It is probably an immature shell which may not reveal clearly the diagnosis. Subsequent collections from the same area help us to understand *P. ezoense*. For instance, GK. H 3022 (Pl. 6, Fig. 3), obtained by T. Matsumoto from loc. U 147-2, Member Ur 2β, which is nearly as large as the holotype, has weak major ribs for about 70° in the last part of the septate whorl. Many other examples from other areas, e.g. GK. H 2052 a–c from loc. N 143 a, unit Mh6α2 (Santonian) of the Naibuchi area, show similar features.

The described specimens from the Soya area have similarly faint ribs on the late part of the phragmocone and more distinct ribs on the body-chamber.

On the other hand, *P. forbesianum* (d'Orbigny, 1850) has been understood to have no major ribs, but is very similar to *P. ezoense* in other respects. Whether it is truly devoid of distinct ribs on the adult body-chamber or not should be examined in the future. For the time being we follow Matsumoto (1942) to distinguish the two species. It should be noted that Usher (1952, p. 53, pl. 2, figs. 1, 2) reported an example from Hornby Island, British Columbia in which "very faint rib-like undulations" cross the outer flank and venter on its body-chamber. This may suggest that a subspecific separation could be considered between *forbesianum* (s.s.) and *ezoense*.

The ribbing in our form is so distinct that it is homoeomorphic with that of *Cymatoceras pacificum* Matsumoto et Muramoto, 1983 (p. 92, pl. 18, fig. 1; pl. 19, fig. 1; pl. 20, figs. 1, 2), although the latter has a backward ventral sinus.

Occurrence:–The described two specimens are from the Fukiyose Member of Kiyohama-I,

upper part of the Zone of *Sphenoceramus schmidti*.

Many other smaller specimens occur from the same member and also from the next higher and next lower zones in the Soya area; also some specimens from the Uttsu and the Wembets-Rubeshbe in the prolific part of the Zone of *Metaplacenticeras subtilistriatum*, although the description is omitted in Part 1.

Suborder Ammonitina Hyatt, 1867
Superfamily Desmoceratacеae Zittel, 1895
Family Desmoceratidae Zittel, 1895
Genus *Desmophyllites* Spath, 1929
Desmophyllites diphylloides (Forbes, 1846)

Descriptive remarks:–Examples of this species from the Teshio Mountains have already been described in Part 1. There are numerous specimens from the Soya area. One of them, about 56 mm in diameter, shows the apertural margin which has a long ventral projection.

Occurrence:–Common in the Zone of *Metaplacenticeras subtilistriatum* (especially its lower part, i.e. beds with *Schlueterella kawadai*) and the Zone of *Sphenoceramus schmidti*, and also their intervening part.

Family Pachydiscidae Spath, 1922
Genus *Pachydiscus* Zittel, 1884

Type species:–*Ammonites neubergicus* Hauer, 1858 (subsequent designation by de Grossouvre, 1894, p. 177).

Remarks:–The remarks given by Jones (1963, p. 35) and Matsumoto (*in* Matsumoto *et al.*, 1979, p. 50) may be generally acceptable. The genus has been subdivided into two subgenera, *P.* (*Pachydiscus*) and *P.* (*Neodesmoceras*) Matsumoto, 1947.

P. (*Pachydiscus*) is high whorled, more or less compressed, fairly involute, with variable but fairly narrow umbilicus, and ornamented with primary and secondary ribs, of which the primary ribs are normally provided with an umbilical bulla or tubercle.

In the typical subgroup, represented by *P. neubergicus*, *P. egertoni* (Forbes) and *P. gollevillensis* (d'Orbigny), the ornament is differentiated into distant and normally short major ribs which are extended from umbilical bullae and numerous, ventrolateral ribs. There may be a nearly smooth zone or a zone of weakened ribs between the two kinds of ornament. In some cases, as seen in *P.* (*P.*) *flexuosus* Matsumoto, 1979 (*in* Matsumoto *et al.*), this differentiation takes place only in a limited part of growth-stage. The species belonging to the typical subgroup are of Maastrichtian age. *P. flexuosus* and *P. subcompressus* Matsumoto, 1954 are examples of this subgroup from Japan and Sakhalin.

P. excelsus Matsumoto, 1979 (*in* Matsumoto *et al.*) has been assigned to the subgroup of *P. gollevillensis*–*P. neubergicus*, but is recorded to have come from the Campanian part of the Hakobuchi Group. Actually its locality is in an area with complicated geological structure (Matsumoto *et al.*, 1979, p. 53, text-fig. 3) and may need further study as to its stratigraphic position. Taxonomically it is allied to *P. gollevillensis* but the differentiation of the umbilical and ventrolateral ornament is not so distinctly manifested and it shows only an incipient tendency towards that character.

P. suciaensis (Meek, 1862), from the upper part of the Nanaimo Group, also shows indistinctly a tendency to the differentiation of ornament into distant primary ribs with umbilical bullae and numerous secondary ribs on the ventral part. The primaries are, however, extended to or branched into the secondaires. The age of this species is yet unsettled, although it is somewhere near the Campanian-Maastrichtian boundary (Ward, 1978a, b).

There are many species of *Pachydiscus* in which the differentiation of the ornament does not occur. They are not of a single homogeneous group. They show various features in shell-form and ornamentation. Some of them, e.g. *P. preegertoni* Collignon, 1955; *P. hidakaensis* Matsumoto et Kanie, 1979 (*in* Matsumoto *et al.*); etc., are allied to certain different species of the *neubergicus-gollevillensis* subgroup, some others (e.g. *P. hornbyense* Jones, 1963 and *P. colligatus* Binkhorst, 1861) are related to some species of *Anapachydiscus*, a few (e.g. *P. ootacodensis* (Stoliczka, 1865) emended by Jones, 1963) with weakening ribs and obsolete umbilical bullae in the late growth-stage show a step forward to *Neodesmoceras*, and still others (e.g. *P. sahekii* sp. nov. described below) have peculiar features which suggest independent lines of descent. Moreover, these various species or species groups are intimately related one to another. Because of this situation, it is better to refer all of these various species to *Pachydiscus*, without subdividing subgenera.

We do not prefer to use the subgroup of *P. colligatus*, the term which was suggested by some authors. It is not clear whether that subgroup means the group of *Pachydiscus* species which lack the tendency to differentiate into umbilical and ventral ribs, or it implies a group of species with comparatively more inflated whorls or otherwise. Some species are compressed but have the ribbing of *colligatus* type.

Neodesmoceras Matsumoto, 1947 was proposed as a subgenus of *Pachydiscus*. Its subgeneric ranking was kept also by Jones (1963) and Matsumot *et al.* (1979), but Collignon (1955, 1971) separated it as a distinct genus. Taxonomically it is distinguished from *Pachydiscus* in its nearly smooth shell, with much weakening or disappearance of ribs and umbilical bullae at early growth-stage onward. Although there are a few species which show transitional features from *Pachydiscus* to *Neodesmoceras*, they are conventionally referred to *Pachydiscus* (e.g. *P. ootacodensis*), since they do have umbilical bullae in early growth-stages and their ribs are better perceptible than in *Neodesmoceras*. As *Patagiosites* is separated from *Canadoceras* or *Nowakites*, it is now better to separate *Neodesmoceras* from *Pachydiscus* as an independent genus.

Distribution:—World-wide in the Campanian and Maastrichtian.

Pachydiscus soyaensis sp. nov.

Pl. 11, Fig. 1; Pl. 12, Fig. 1; Pl. 13, Fig. 1; Pl. 16, Fig. 1; Pl. 17, Fig. 3; Pl. 21, Fig. 3

Material:—Fairly numerous specimens from Soya harbour are in the Collection of MNH, of which the followings are selected for the description:

Holotype: GK. H5972 [=MNH. 125] (Pl. 11, Fig. 1) from W7B. Paratypes: MNH. 124 (Pl. 12, Fig. 1), MNH. 119 (Pl. 17, Fig. 3), MNH. 202 (Pl. 13, Fig. 1), MNH. 203 and MNH. 204 (Pl. 21, Fig. 3) from W7A; MNH. 120 (Pl. 16, Fig. 1) from W7B. MNH. 124 collected by S. Hayama, MNH. 203 & 204 by H. Honma and others by T. Miyauchi.

Diagnosis:—Shell fairly large, moderately involute, with fairly narrow umbilicus. Whorl rounded suboval in cross-section, with moderately arched venter, rather gently convex flanks

and the proportion of B/H about 0.9.

Ribs numerous, 42 to 55 per whorl, narrow and weak. Long ribs provided with a bullate tubercle at or near the umbilical shoulder and gently concave or sometimes gently flexuous in lateral view; one to three shorter ribs intercalated between (or sometimes branched from) the longer ones. On the venter all the ribs projected gently forward. Finely and deeply incised sutures as in *P. colligatus*.

Dimensions:–

Specimen	D	U	H	B	B/H	Ribs/90°
MNH. 125	122.0	28.4 (.23)	59.5 (.49)	56.5 (.46)	0.95	13–14
MNH. 124	112.0	23.2 (.21)	55.0 (.49)	52.0 (.96)	0.95	18
MNH. 119	118.0	22.0 (.19)	64.0 (.54)	57.5 (.49)	0.90	16+2
MNH. 203	~140.0	31.0 (.22)	77.0 (.55)	~70 (.50)	0.91	15
MNH. 204	65.0	15.0 (.23)	30.0 (.46)	~27 (.41)	0.9	13
MNH. 202	88.0	17.4 (.20)	47.0 (.53)	36.0 (.41)	0.88	16

Description:–All the available specimens are somewhat but not much distorted, except for a few highly deformed ones. The above dimensions are on the actual specimens without restoration.

The holotype is almost wholly septate with only a posterior fraction of the body-chamber. No complete body-chamber is preserved in the available material. Should it be preserved, the entire shell diameter would be fairly large, attaining presumably to about 150 mm (holotype) to 200 mm (MNH. 203).

The shell is fairly involute and the umbilicus is fairly narrow, 20 to 23% of the diameter. The whorl increases with a moderate rate, showing the increase of whorl-height from 40 mm to 60 mm in a half volution. It is somewhat (but not much) higher than broad, showing B/H = 0.9 or so, unless the specimen is secondarily compressed. The umbilical wall is steep, passing through a rounded umbilical shoulder to a moderately to gently convex flank. The venter is moderately arched, although there is some variation in the degree of arch-curvature. For example, the venter is moderately rounded in the holotype, but it is more narrowly arched in MNH. 119; the intermediate state is shown by MNH. 124. The whorl is broadest in the lower part between the mid-flank and the umbilical shoulder.

The ribs are numerous, rather narrow and weak. There is, however, variation in these respects. The holotype represents a comparatively more coarsely costate form. There are only 11 ribs per quarter whorl on the earlier part with height of 30 to 35 mm. At about the same stage more numerous (15 per quarter whorl) and finer ribs are seen in MNH. 39 and the intermediate state is seen in MNH. 204. At this stage, regardless the variation in rib density, the ribs normally diverge from a bullate tubercle and the tubercle itself is septate at the base, suggesting the originally spinose character.

In the late part of the whorl, the ribs become somewhat more numerous and the tubercles become weaker and more elongated, tending to disappear finally. One or two, or occasionally three, shorter ribs of unequal length are intercalated between the tuberculate long ones. Many of the shorter ribs arise well below the mid-flank, some of which start near the umbilical shoulder without tubercle. The ribs are not weakened at the mid-flank. On the main part of the flank some ribs are gently flexuous, some others gently concave and a few nearly rectiradiate. All the ribs cross the venter with a gently forward curvature. In the distorted specimens

this curvature may be modified.

The suture is finely and deeply incised as in typical *Pachydiscus*. This character is already shown on the immature stage, as seen on MNH. 204.

Comparison and discussion:–This new species resembles *Pachydiscus colligatus* (Binkhorst) (1861, p. 25, pl. 8; pl. 8a, figs. 1–3) (de Grossouvre, 1894, p. 202, pl. 24, figs. 1, 2; pl. 33, fig. 1; 1908, p. 28, pls. 4–8), from the Lower Maastrichtian of Europe and Madagascar (Collignon, 1955, p. 74, pl. 26, fig. 2; 1971, p. 32, pl. 653, fig. 2409), in the general aspects of shell-form, ornamentation and sutural pattern, but is distinguished by its finer, weaker and more numerous ribs, especially in the late growth-stage. The variation in shell-form may overlap between the two species, but *P. colligatus* seems to include a form with more inflated flanks and a more broadly rounded venter.

With respect to the shell-form, *P. soyaensis* is closely similar to *P. precolligatus* Collignon (1955, p. 64, pl. 21, fig. 1; pl. 25, figs. 2, 3; 1970, p. 40, pl. 624, fig. 2313), from the Middle Campanian Zone of *Delawarella subdelawarensis* of Madagascar, but the latter has more distant and less numerous ribs. Even the densicostate variety of that species has less numerous ribs than those of *P. soyaensis* (36 as compared with 42–55). Some examples of *P. precolligatus* have a wider umbilicus and broader whorls than most of *P. soyaensis*.

In having the numerous fine ribs and the weakened umbilical bullae on the outer whorl, *P. soyaensis* somewhat resembles *P. neevesi* Whiteaves (1903, p. 342, pl. 47, fig. 1; text-fig. 21) (Usher, 1952, p. 87, pl. 22, figs. 1, 2; pl. 31, fig. 7) (with holotype designated by Whiteaves in the explanation of plate), from the Cedar District Formation of the Nanaimo Group (Vancouver Island), but the latter is more compressed, with higher whorls and less convex, flatter flanks and has weaker, almost reduced elevation of the long ribs at the umbilical shoulder on both the outer and the inner whorls.

P. hornbyensis Jones (1963, p. 38, pl. 38, figs. 2–6; pl. 33; text-fig. 19), from the "Lambert Formation" (=Northumberland Formation) of the Nanaimo Group, has broader whorls with more inflated flanks and more distant, less numerous ribs, although its weakened narrow ribs on the outer whorl are similar to those of *P. soyaensis*.

Occurrence:–The holotype and other specimens were obtained from calcareous nodules at W7A and W7B of Miyauchi, which had been excavated from the bed rock of the Soya harbour. Judging from the greenish dark grey fine-sandy siltstone of the matrix as well as the associated specimens, they must have come from a particular fossiliferous layer which is characterized by *Schlueterella kawadai* sp. nov.

Pachydiscus sahekii sp. nov.

Pl. 14, Fig. 1; Pl. 15, Fig. 2; Pl. 16, Fig. 2

Material:–Four specimens obtained from the excavated rocks of the Soya harbour. Holotype GK. H5973, T. Saheki's Collection (Pl. 14, Fig. 1). Paratypes MNH. 188 obtained by Terumasa Masuda (Pl. 18, Fig. 2), MNH. 187 and MNH. 189 (Pl. 15, Fig. 2) by T. Miyauchi.

Diagnosis:–Shell very large, moderately involute, with fairly narrow umbilicus. Whorl suboval in corss-section, somewhat higher than borad (B/H about 0.8), broadest in the lower part, with narrowly arched venter, somewhat convex flanks and rounded umbilical shoulder.

In early growth-stage (with diameters from 60 to 150 mm), ribs numerous, weak and fine but separated by wider interspaces, projected on venter. Some of the longer ribs provided

with narrow and elongated bulla above the umbilical shoulder. In the succeeding stage, ribs numerous, crowded and weak, some of which are fasciculated from the periodic umbilical bullae and others intervening. In the next, fairly large stage the umbilical bullae thickened and elongated, forming major ribs which are subdivided into two to three finer ribs at about mid-flank; other intervening ribs of unequal length, with intercalation or branching, crowded and numerous but weak. In the final stage, major broad ribs, with some thickned bullae above or at about the umbilical shoulder, and some intercalated short but thick ribs distributed at wide distance, without or with much reduced minor ribs on the interval. All the ribs gently arcuate at first and later more strongly so, showing forward concave curvature in laterl view and distinct projection on the ventral part.

Suture finely and deeply incised as in other species of *Pachydiscus*.

Dimensions:–

Specimen	D	U	H	B	B/H
Holotype	310.0	68.5 (.22)	145.5 (.47)	118.0 (.38)	0.81
" (−170°)	–	–	102.0	84.5	0.83
MNH. 189	134.0	29.0 (.22)	69.0 (.51)	54.8 (.41)	0.79
For comparison holotype (from original description) of					
P. preegertoni	186	47 (.25)	83 (.45)	73 (.39)	0.88
P. spissus	81	20 (.25)	41 (.51)	39 (.48)	0.95
P. soyaensis	122.0	28.4 (.23)	59.5 (.49)	56.5 (.46)	0.95

Description:–Holotype is wholly septate and there is a trace of the umbilical seam for still one full whorl. As the rate of increase of whorl-height is moderately large (about 1.5 per half whorl), the entire shell diameter would exceed 500 mm at the full-grown stage.

MNH. 187 and MNH. 188 are also incompletely preserved but their restored shape would be likewise very large. One of them, MNH. 188 shows both the inner whorl with numerous, dense ribs and periodic major ribs and the outer whorl with distant, coarse ribs. The other, MNH. 187, is a fragmentary outer whorl which has distant concave coarse ribs with gently thickening at about the umbilical shoulder, but it is still septate at H = 220 mm.

MNH. 189 (Pl. 15, Fig. 2) represents the inner whorl of this species, being outside the variation of *P. soyaensis*.

In every specimen no strong tubercle is seen at any stage.

Comparison and discussion:–This species is peculiar in having thick ribs at wide intervals on the outer whorl. Unlike species of *Eupachydiscus*, it has no strong tubercles at any stage, with only bluntly thickened umbilical bullae, and its inner whorl is more compressed and has denser, more numerous, weaker ribs.

In the proportion of B/H and the presense of coarse ribs in the last stage, *P. preegertoni* Collignon, 1955 (p. 61, pl. 20, fig. 1), from the Middle Campanian of Madagascar, is somewhat similar to *P. sahekii*, but that species is not so large and not so high-whorled as the present species, with more rounded venter, and its septate whorl shows different type of ornamentation, with less numerous, coarser ribs and stronger tubercles without fasciculation.

P. spissus Collignon, 1955 (p. 72, pl. 26, fig. 1) (Collignon, 1970, p. 38, pl. 623, fig. 2311), from the Middle Campanian Zone of *Delawarella subdelawarensis* in Madagascar, is similar to the immature shell of *P. sahekii* in shell-form and numerous ribbing, but that species again has somewhat larger B/H, more rounded venter and its ribs are nearly rectiradiate on the flank,

with less projection on the venter. Whether the *sahekii* type distant ribs appear in the last stage of *P. spissus* or not is not known.

With respect to the numerous ribs with concave curvature, *P. sahekii* is somewhat similar to *P. soyaensis* described above, but the latter has somewhat coarser ribs and stronger tubercles in the early stage and the ribs become finer and more numerous in the late stage. This is opposite to the later coarsening tendency of *P. sahekii*. This new species has a smaller value of B/H, a more narrowly arched venter, laterally more concave and ventrally more projected ribs and a much larger adult shell than *P. soyaensis*.

As to the numerous ribs and the gentle elevation of the long ribs at about the umbilical shoulder up to a certain growth-stage, *P. sahekii* is similar to *P. excelsus* Matsumoto, 1979 (*in* Matsumoto *et al.*, p. 50, pl. 8, fig. 1; text-fig. 2), from the Campanian sandstone of the Hakobuchi Group (central Hokkaido), but the latter has much more compressed whorls and shows flexuosity of the ribs which tend to be weakened on the middle of flanks.

Occurrence:–The holotype and the three paratypes were in the green silty sandstone excavated from the submarine bottom of the Soya harbour. The original bed is certainly referred to the bed characterized by *Schlueterella kawadai* sp. nov., immediately below the dark grey sandy siltstone characterized by *Metaplacenticeras subtilistriatum* (Jimbo).

Genus *Anapachydiscus* Yabe et Shimizu, 1926

See Part I (p. 13) for the general account of this genus.

From the Upper Campanian of the Soya area two species of *Anapachydiscus* have been found, although they are represented by incompletely preserved specimens.

Anapachydiscus cf. *A. fascicostatus* (Yabe, 1921)

Pl. 22, Fig. 3

Material:–MNH. 195A (external mould) and MNH. 195B (a portion of the shell of the same individual) collected by T. Miyauchi. (The internal mould of the shell seems to have been taken away by someone.)

Descriptive remarks:–The original specimen would be about 220 mm in diameter of a restored outline. The umbilicus measured on the external mould is 49.5 mm, that is 22.5% of D. The whorl is broader than high, but the value of B/H cannot be precisely estimated. It has a steeply incurved umbilical wall, abruptly rounded umbilical shoulder, convex flanks and broadly rounded venter. The degree of inflation suggested by the external mould is not so remarkable as that of the holotype, but there may be an effect of secondary deformation.

Numerous fine ribs run nearly radially on the flank and curved slightly forward on the venter. Some of the ribs are fasciculated from the periodic tubercles above the umbilical shoulder. The tubercle has a radially elongated base and seems to be much pointed or presumably spinose in the well preserved state.

The observed characters enable us to identify it probably with *A. fascicostatus*, which is redescribed in Part I.

Occurrence:–Solitarily in greenish, partly cross-laminated, fine-grained sandstone, at a point on the coast about 900 m SSW of the Soya harbour. A fragmentary shell of *Metaplacenticeras* sp. occurs in the same rock mass. The bed is referred to Member J above the dark

coloured, more or less sandy silstone (Member I) with more commonly occurring *M. subtilistriatum* (Jimbo).

Anapachydiscus cf. *A. deccanensis* (Stoliczka, 1865)

Pl. 15, Fig. 1

Compare:–

1865. *Ammonites deccanensis* Stoliczka, *Palaeont. Indica*, ser. 3, no. 7, p. 126, pl. 63, fig. 1.
1898. *Pachydiscus deccanensis* (Stoliczka); Kossmat, *Beitr. Palaeont. Geol. Oesterr. Ung. Orients*, vol. 11, p. 168.
1947. *Anapachydiscus yezoensis* (Yabe MS) Matsumoto, *Sci. Rept. Dept. Geol., Kyushu Univ.*, vol 2, no. 1, pl. 41, text-fig. 1.
1955. *Anapachydiscus deccanensis* Stoliczka var. *menabensis* Collignon, *Ann. Geol. Serv. Mines*, no. 21, p. 57, pl. 18, fig. 3.
1955. *Anapachydiscus deccanensis yezoensis* Matsumoto; Matsumoto, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 5, no. 3, p. 179.
1979. *Anapachydiscus deccanensis yezoensis* Matsumoto; Matsumoto, *Trans. Proc. Palaeont. Soc. Japan*, n.s., no. 113, p. 44, pl. 7, fig. 1.

Material:–MNH. 190 (Pl. 16, Fig. 1), MNH. 192, MNH. 191 and MNH. 193 from loc. W7B (nodule no. 47) collected by T. Miyauchi.

Description:–The above four specimens are distorted, rather small for the genus and probably immature. They represent a species of *Anapachydiscus* other than *A. fascicostatus* occurring in the Upper Campanian of the Soya area.

One of them, MNH. 192, shows the following dimensions under the distorted condition:

D = 70.0 U = 17.0 (.24) H = 31.0 (.44) B = 42 (.60) B/H = 1.35

Three others, though distorted in various way, suggest the shell-form similar to the above. Thus, the shell is fairly involute with a fairly narrow umbilicus. The whorl is depressed, with inflated flanks and a broadly rounded venter, although the original degree of inflation cannot be precisely estimated.

Ribs are narrow but not so fine and so numerous as those of *A. fascisostatus*. In general they are gently concave on flank and moderately projected on venter, although the curvature is modified by secondary distortion. The tubercles have subrounded or bullate base. Their pointed summit is unpreserved. In the young stage weak constrictions may be discernible along the tuberculated ribs. There are 9 tubercles in a whorl of MNH. 192. Two or three ribs diverge from each tubercle. There are two or three intervening ribs at each interval. There seem to be some variation in the rib density. For example, ribs are denser and more numerous in MNH. 191 than in MNH. 192. The small shell of MNH. 190, about 35 mm in diameter, has weaker ribs than others but the tubercles are already prominent, with a large rounded base.

Sutures are deeply and finely incised. Even in the small specimens the stems of the lobes are much narrowed.

Comparison:–In all the above characters the described specimens can be identified probably with *A. deccanensis*. Because of their small size and distorted condition, it is difficult to give a subspecific name. As to the relations of *A. deccanensis* with other species, see Matsumoto (1955, p. 181).

Occurrence:–In a calcareous nodule (W7B-47) excavated from the green silty fine-grained sandstone at the bottom of the Soya harbour, belonging to the Subzone of *Schlueterella kawadai*.

Genus *Pseudomenuites* Matsumoto, 1955

Type species:–*Pachydiscus ambiguus* de Grossouvre, 1894 (original designation).

Generic diagnosis:–Very similar to *Pachydiscus* in the compressed shell-form, the type of ornaments and the sutural pattern, but smaller and provided with ventrolateral tubercles in a late growth-stage.

Pseudomenuites sp.

Pl. 16, Fig. 1; Pl. 17, Fig. 1

Material:–MNH. 121 collected by T. Miyauchi from loc. W7B, Soya harbour.

Description:–The specimen is somewhat distorted and incompletely preserved. Its unrestored dimensions are as follows:

D = 82(1), U = 19(.23), H = 39(.47), B = 30(.36), B/H = .77

The whorl is somewhat higher than broad, subelliptical in section, with a rounded venter and gently convex flanks.

The shell in the late growth-stage has several narrowly raised ribs at wide intervals. They have bullate umbilical tubercles and three of them have narrow but spinose ventrolateral tubercles. Numerous, very weak, fine ribs of unequal length are discernible on the interspaces of the major ribs. The ribs are nearly rectiradiate or slightly arcuate, projecting gently forward on the venter. The immature shell has numerous, fine ribs.

Partly exposed suture is of *Pachydiscus* pattern.

Comparison and discussion:–This species is similar to *Pachydiscus soyaensis* sp. nov. (described above) but is smaller and has ventrolateral tubercles in a limited part of the late growth-stage. Actually the described specimen (MNH. 121) is closely in contact with the apertural part of a larger specimen (MNH. 120) of *P. soyaensis*, as shown in Pl. 16, Fig. 1. It could be possibly considered that the two forms might represent a dimorphic pair. While the macroconch, *P. soyaensis* without ventrolateral tubercle, occurs fairly commonly, the microconch, *Pseudomenuites* sp. described here is found very rarely.

As the material is too incomplete, we defer to give a new specific name.

Occurrence:–In one of the excavated block from the bed with *Schlueterella kawadai* under the sea-water of Soya harbour.

Genus *Canadoceras* Spath, 1922

Canadoceras multicostatum Matsumoto, 1954

Pl. 18, Figs. 1–2; Pl. 20, Fig. 2

Material:–MNH. 205, MNH. 206 (Pl. 18, Fig. 1), MNH. 207 (Pl. 18, Fig. 2) and other fragmentary specimens (e.g. MNH. 107, 108, 169) from the *Schlueterella kawadai* Bed of Soya horbour; MNH. 505 (Pl. 20, Fig. 2) from the Fukiyose Bed of Kiyohama-I. See also Part I, p. 18.

Description:–MNH. 205 and MNH. 206, though secondarily compressed and of imperfect preservation, are huge example of this species which looks superficially like *Mesopuzosia*, being similar to the one originally described by Matsumoto (1954a, p. 307, pl. 34, fig. 2). The outer whorl, with height of about 160 mm, has a nearly smooth surface. The next

inner whorl, with heights of 80 to 100 mm, has numerous ribs which are projected on the ventral part. At this stage constrictions are indistinct or faintly and infrequently discernible. The preceding whorl of the middle growth-stage is similar to the holotype.

MNH. 505 (Pl. 20, Fig. 2), which is stratigraphically lower than the above mentioned large specimens, is small and possibly immature, although the last suture is immediately behind the preserved end. It is more involute and more narrowly umbilicate than some other immature specimens (e.g., inner whorls of holotype, see Matsumoto, 1954a, pl. 34, fig. 1; text-fig. 28 (74) and the one described in Part I of this paper). Its dimensions are shown below:

Position	D	U	H	B	B/H
−45°	74.0	21.2 (.29)	30.5 (.41)	22.8 (.31)	0.75
−180°	—	—	22.4	17.4	0.78

It is, however, very similar in shell-form to a specimen GK.H3457 from the Urakawa area described by Matsumoto (1954a). Its major ribs corresponding to constrictions are frequent and provided with umbilical tubercles from fairly early growth-stage. The ribs intervening between the periodic major ones are numerous, rather crowded, of unequal length, gently flexuous or concave on flank and considerably projected on venter. Some of them are unusually finer and weaker than the normal ones. Despite some peculiarity, this specimen is regarded as an intraspecific variety of *C. multicostatum*.

Occurrence:—In the Soya area *C. multicostatum* occurs fairly commonly from the silty green sandstone of the *Schlueterella kawadai* Bed which constitutes the submarine basement of the Soya harbour. The higher bed of hard and coarse sandstone, which is exposed along the coast line north of Soya harbour, is generally poor in fossil, but we have obtained from this bed a fairly large specimen of this species. On the other hand, in the upper part of the Fukiyose Member, exposed on a wave-cut bench off the coast of Kiyohama-I and other places, this species is occasionally found. It has not yet been found from the *Metaplacenticeras* Bed (s.s.) of the Soya area, but this may be collection failure, since it occurs in the Zone of *M. subtilistriatum* of the Teshio Mountains.

Canadoceras mysticum Matsumoto, 1954

Pl. 19, Figs. 2–3; Pl. 20, Fig. 3

1954. *Canadoceras mysticum* Matsumoto, *In* Matsumoto (ed.): *Cretaceous System of the Japanese Islands*, p. 307, pl. 31, fig. 2; pl. 35, figs. 1, 2; text-figs. 75, 76.

1959. *Canadoceras mysticum* Matsumoto; Matsumoto, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, spec. vol. 1, p. 59, pl. 15, figs. 2, 3.

Holotype:—GK. H5184, from the Zone of *Sphenoceramus schmidti*, Teshio Province, Hokkaido (Matsumoto, 1954a, pl. 35, fig. 1). Matsumoto (1954a) indicated two immature paratypes, one of which, GK. H5206, was misprinted in p. 307 as H5276.

Material:—Four specimens, MNH. 506, MNH. 507, MNH. 48 and MNH. 50 represent this species from the Fukiyose Beds of Kiyohama-I. Some others in A. Tanabe's Collection.

Diagnosis:—A species of *Canadoceras* of moderate size, characterized by nearly flat parallel flanks and compressed whorls, fairly frequent, prorsiradiate constrictions accompanied by major ribs whose umbilical tubercles are inconspicuous or less prominent from early growth-stage onward, and rather weak intervening ribs which are slightly prorsiradiate or gently

flexiradiate on flank and moderately projected on venter.

Dimensions:–

Specimen	D	U	H	B	B/H
MNH. 506	68.2 (1)	20.0 (.29)	28.4 (.42)	23.4 (.34)	0.82
MNH. 507	~81.0 (1)	24.6 (.30)	33.0 (.41)	27.0 (.33)	0.82
" (–90°)	68.6 (1)	20.2 (.29)	28.0 (.41)	23.6 (.35)	0.84
Holotype*	94.0 (1)	26.0 (.28)	40.0 (.42)	31.4 (.33)	0.79
" (–90°)	82.0 (1)	21.5 (.26)	37.0 (.45)	30.0 (.37)	0.81

~ approximate (restored), * remeasured

Description:–The two measured specimens both have the last septum at the preserved end. MNH. 506 is nearly as large as the phragmocone of the holotype, but on its last half whorl ribs become less crowded than those of the holotype at the corresponding size. In other words the mode of ribbing in the last half of its septate whorl is rather similar to that of the body-chamber of the holotype. In other respects MNH. 506 is quite similar to the holotype.

MNH. 507 has more distant, coarser ribs on the last whorl of its septate stage and its periodic major ribs are thicker than those of MNH. 506 and the holotype. The larger adult shell (about 126 mm in D) in Mr. A. Tanabe's private collection has likewise coaser ribs.

The above differences are regarded as variations within the same species, because the two specimens have the diagnostic features in common and occurred in the same bed. A certain extent of variation in the curvature and density of ribs and other features has been mentioned on the specimens from California (Matsumoto, 1959c, p. 59), which have more numerous and finer ribs than in the present specimens.

Comparison and discussion:–The holotype of *C. mysticum* is a nearly complete adult shell, having the body-chamber for about 210°. It is about 100 mm in diameter.

Should the body-chamber be preserved in MNH. 507, the diameter would be 125 mm or so, as in the larger paratype (GT. I-1440 = UMUT. MM9117) (Matsumoto, 1954a, pl. 31, fig. 2). As far as the available material is concerned, *C. mysticum* is of moderate size and smaller than *C. newberryanum* (Meek), *C. kossmati* Matsumoto and *C. multicostatum* Matsumoto.

C. mysticum is distinguished from *C. newberryanum* (Meek) (see Usher, 1952, p. 65 and Matsumoto, 1959c, p. 58) and *C. kossmati* Matsumoto (1954a, p. 295), by its less inflated nearly parallel flanks, prorsiradiate periodic major ribs, much weaker umbilical bullae on the major ribs and weaker intervening ribs.

It has been suggested (Matsumoto, 1959c, p. 60) that the weakening of the ornament in *C. mysticum* may foreshadow *Patagiosites*, but according to Immel *et al.* (1982, p. 19), some examples of *Patagiosites* occur in the Lower Santonian of Austria. They could be a smoothed offshoot of *Nowakites*, if the suture is of *Nowakites* type. Otherwise the above suggestion would be unwarrantable.

Occurrence:–The described specimens and some others are from the Fukiyose Member constituting the wave-cut bench off Kiyohama-I and Kiyohama-II, upper part of the Zone of *Sphenoceramus schmidti*. Holotype and paratypes are from the same zone in Teshio Province and South Sakhalin respectively.

Canadoceras minimum sp. nov.

Pl. 19, Fig. 1; Pl. 20, Fig. 1; Pl. 21, Figs. 1–2

Material:–Four, well preserved, small specimens from the Fukiyose Bed of Kiyohama-I: Holotype GK. H5976 [=MNN. 508] (Pl. 20, Fig. 1); Paratypes GK. H5977 [=MNH. 504] (Pl. 19, Fig. 1), MNH. 142 (Pl. 21, Fig. 2) and MNH. 143 (Pl. 21, Fig. 1), all collected by T. Miyauchi.

Diagnosis:–Shell small, discoidal and fairly involute, with rather narrow umbilicus (21–25% of diameter). Whorl increasing with a considerable rate, a little higher than broad (B/H = 0.96–0.88), suboval to subelliptical in section, with rather narrowly arched venter, gently convex to nearly flat flanks, rounded umbilical shoulder and low but steep umbilical wall.

Ribs fine, numerous, mostly long, though of unequal length, gently flexiradiate to prorsiradiate in lateral view and gently to moderately projected on venter as the shell grows. In early growth-stages (up to diameter of 20 mm or so) the umbilical bullae almost undeveloped or perceptible only as faint elevations on some periodic longer ribs, each of which is accompanied by a faint constriction (or rather to say slightly deeper interspace). In the late growth-stage, bullate umbilical tubercles developed at the end of the prorsiradiate longer ribs immediately behind the periodic constrictions. Ribs somewhat but not much coarsen in the last stage.

Suture as in other species of *Canadoceras*.

Dimensions:–

Specimen	D	U	H	B	B/H
MNH. 508	29.0	6.3 (.22)	12.8 (.44)	~11.8 (.41)	~0.92
" (–90°)	23.2	5.4 (.23)	11.2 (.48)	10.6 (.46)	0.95
MNH. 504	32.0	7.4 (.23)	14.7 (.46)	13.0 (.41)	0.88
MNH. 142	19.5	4.2 (.22)	9.3 (.48)	8.6 (.44)	0.92
MNH. 143	20.8	4.6 (.22)	9.8 (.47)	8.9 (.43)	0.91

Description:–The holotype has the last suture somewhat behind the preserved end and only a posterior fraction of the body-chamber remains. MNH. 504 is wholly septate and there is a trace of the umbilical seam for about a half whorl. Therefore, its original shell would be as large as 55–60 mm in diameter. Anyhow, this size is small. Although numerous specimens have been obtained from the Fukiyose Beds of the type locality (i.e. wave cut bench off Kiyohama-I), no large example which could fit the above described small specimens has been found. Therefore, this species is interpreted as being characterized by its small size.

MNH. 123 and MNH. 124 represent immature shells which correspond to the younger part of the holotype. In this immature stage bifurcation of the rib takes place frequently at or near the umbilical shoulder in addition to the intercalation. In the late growth-stage simple ribs become predominant and they tend to be gradually (but not much) coarser and less crowded. The major rib and the associated constriction is generally more prorsiradiate than the ribs behind it.

Comparison and discussion:–This species is unique in its small size, fine, dense, numerous ribs and very weak umbilical bullae on comparatively less prominent, prorsiradiate major ribs. In these respects it is allied to *C. mysticum* Matsumoto (described above). The young shell or inner whorl of *C. mysticum* as small as the holotype or paratypes of the present species is less involute and has somewhat wider umbilicus, more frequent and more distinct, periodic major ribs and finer and more crowded intervening ribs which may be called lirae. Therefore,

we do not regard the described specimens as young shells of *C. mysticum*. This species is distinct from *C. mysticum*, but it may be a dwarfed offshoot from that species.

In the mode of ornamentation, this species is somewhat similar to *C. tanii* Matsumoto et Morozumi, 1980 (p. 7, pl. 2, fig. 1), from the Lower Maastrichtian (or possibly uppermost Campanian) of the Izumi Group in Southwest Japan, but *C. tanii* is larger (more than 200 mm in diameter at the adult stage) and has much more compressed whorl (B/H = 0.6 to 0.7).

C. hoepeni Collignon, 1955 (p. 47, pl. 12, fig. 1; 1970, p. 28, pl. 618, fig. 2303), from the Middle Campanian of Madagascar, is similar to *C. minimum* in shell-form, but it is larger and more distinctly constricted on the inner whorl.

Occurrence:–The described specimens were found from one of the Fukiyose Beds of the wave-cut bench off the coast of Kiyohama-I, which is assigned to the upper part of the Zone of *Sphenoceramus schmidti*.

Superfamily Hoplitaceae H. Douvillé, 1890
Family Placenticeratidae Hyatt, 1900
Genus *Metaplacenticeras* Spath, 1926
Metaplacenticeras subtilistriatum (Jimbo, 1894)
Pl. 22, Figs. 1–2

Material:–MNH. 198, MNH. 202 (Pl. 22, Fig. 1) and several other specimens from Soya harbour and its neighbourhoods and MNH. 196 and MNH. 201 (Pl. 22, Fig. 2) from Kiyohama-II; all collected by T. Miyauchi.

Dimensions:–

Specimen	D	U	H	B	B/H
MNH. 196*	63.0 (1)	12.0 (.19)	30.5 (.48)	–	–
MNH. 197*	70.0 (1)	12.0 (.17)	36.0 (.51)	–	–
MNH. 202*	50.5 (1)	9.0 (.18)	27.0 (.53)	9 (.18)	0.33

* Measured on deformed specimens as they are.

Descriptive remarks:–In many cases the specimens of this species from the Soya area are poorly preserved, because they are not contained in calcareous nodules. Therefore, the dimensions measured above are approximate and especially the precise ratio of B/H is hardly known.

Despite this drawback, they match well with the better preserved specimens from the Teshio Mountains (described in Part 1, p. 21) in the essential features of the diagnosis.

As in the case of the Teshio Mountains, there are two forms, one with distinct ribs on the outer whorl (Pl. 22, Fig. 1) and the other in which ribs are very weak but striae or lirae are distinct (Pl. 22, Fig. 2).

Occurrence:–Common in a dark grey silty (sometimes sandy) bed under the sea-water of Soya harbour, its extensions in the south and also in the north up to Kiyohama-II. Also occasionally found in the underlying green silty fine sandstone with *Schlueterella kawadai* and overlying unit of alternating sandstone and siltstone.

Suborder Lytoceratina Hyatt, 1899
Family Tetragonitidae Hyatt, 1900
Genus *Tetragonites* Kossmat, 1895

Type species:—*Ammonites timotheanus* Pictet, 1848 (original designation).

Remarks:—For the up-to-date general account of this genus, see Kennedy and Klinger (1977b, p. 151), whom we follow.

Tetragonites superstes van Hoepen, 1921

Pl. 23, Fig. 2

1921. *Tetragonites superstes* van Hoepen, *Ann. Transv. Mus.*, vol. 8, p. 10, pl. 2, figs. 17–20, text-fig. 6.
1922. *Tetragonites superstes* van Hoepen; Spath, *Trans. Royal Soc. S. Afr.*, vol. 10, pt. 3, p. 119, pl. 6, fig. 6.
1956. *Epigoniceras superstes* van Hoepen; Collignon, *Ann. Geol. Serv. Mines*, fasc. 23, p. 87, pl. 11, fig. 3.
1969. *Epigoniceras superstes* van Hoepen; Collignon, *Atlas des Fossiles Caracteristiques de Madagascar*, fasc. 15, p. 14, pl. 517, fig. 2035.
1977. *Tetragonites superstes* van Hoepen; Kennedy and Klinger, *Ann. S. Afr. Mus.*, vol. 73, pt. 7, p. 162, figs. 7A–D, H–J, 8, 12A-c.

Material:—MNH. 502 collected by T. Miyauchi from the Fukiyose Bed of Kiyohama-I.

Descriptive remarks:—*T. superstes* van Hoepen has been recently redescribed in detail by Kennedy and Klinger (1977b). The present specimen presents well the specific diagnosis. It is moderately involute, fairly narrowly umbilicate, showing a moderate rate of increase. Its whorl is slightly broader than high, broadest immediately below the mid-flank, subquadrate to subrounded in section, with a rounded venter, nearly flat to gently convex flanks, abruptly rounded umbilical shoulders and subvertical umbilical wall of moderate height.

The shell surface is nearly smooth, only with very fine growth striae and inconspicuous, periodic constrictions. They run almost radially on the umbilical wall, are remarkably prorsiradiate on the flank, curved backward at the rounded ventrolateral shoulder and cross the venter with a slight backward sinus. The elevation of the shell corresponding to the constriction is slight. Four constrictions are discernible on the outer whorl.

Suture is not much complex and characterized by unequally trifid major saddles and distinctly bifid lateral lobe (L).

Dimensions:—

Specimen	D	U	H	B	B/H
MNH. 502	41.3	11.7 (.28)	17.7 (.43)	18.6 (.45)	1.05
From Kennedy and Klinger, 1977b, p. 162.					
Holotype	40.0	10.4 (.26)	17.3 (.43)	18.2 (.45)	1.05

Occurrence:—Fukiyose Bed exposed on wave cut bench off the coast of Kiyohama-I. In the same nodule *Sphenoceramus schmidti* is contained.

Tetragonites popetensis Yabe, 1903

Pl. 23, Fig. 3

1903. *Tetragonites popetensis* Yabe, *Jour. Coll. Sci., Imp. Univ. Tokyo*, vol. 18, art. 2, p. 48, pl. 7, figs. 4, 6.

Holotype:—UMUT. MM7460 (=I-207) (Yabe, 1903, pl. 7, fig. 4) from the upper part of the Upper Yezo Group of the Sanushibe, Hobetsu (=Popets) area, central Hokkaido.

Material:–MNH. 501, from the Fukiyose Bed of Kiyohama-I, collected by T. Miyauchi.

Description:–This specimen is well preserved, although a part of its body-chamber is slightly displaced. It is larger than the holotype (see *dimensions*), about 70 mm in diameter, and has the body-chamber for about 250°. The last suture is well exposed. In the essential points, it matches well the holotype. A revised specific diagnosis may be as follows:

Shell rather small, discoidal, showing moderately involute coiling and moderate rate of whorl increase. Umbilicus of moderate width, surrounded by nearly vertical, moderately high wall and subangular to abruptly rounder shoulder. Whorl a little broader than high or nearly as high as broad, subrounded to subquadrate in section, with nearly flat and parallel flanks and rounded venter.

Surface nearly smooth, only with very fine growth striae. Constrictions and associated rib-like elevations moderately frequent but very weak in the main growth-stages, becoming more frequent and better marked on the last half of the body-chamber. Growth striae and constrictions extremely prorsiradiate on the flank and bent backward at the ventrolateral shoulder, crossing the venter with a backward sinus.

Suture of *Tetragonites* pattern, with apparently trifid major saddles and bifid lateral lobe (L).

Dimensions:–

Specimen	D	U	H	B	B/H
MNH. 501 (–60°)	66.6	21.2 (.32)	26.4 (.40)	27.0 (.41)	1.02
" (–250°)	44.0	14.0 (.32)	18.4 (.42)	19.2 (.44)	1.04
From Yabe, 1903, p. 48.					
Holotype	34	10.5 (.31)	14.5 (.43)	15.0 (.44)	1.03

Comparison:–*T. popetensis* Yabe resembles *T. epigonus* (Kossmat) (1895, p. 135, pl. 17, figs. 4, 5, 10), from the Turonian to Campanian of various regions of the world (see Kennedy and Klinger, 1977b, p. 165, 167), but is distinguished in having a somewhat wider umbilicus, nearly parallel instead of convergent flanks and wider stem of lateral lobe.

One of us (Matsumoto, 1959c, p. 152) has already described some examples of *T. popetensis* from California.

The form described under *Lytoceras* (*Tetragonites*) *kingianum* Kossmat var. *involutior* Paulcke (1907, p. 8, pl. 17, figs. 3, 4), from the Campanian of Patagonia, is similar to *T. popetensis* in shell-form but is distinguished in lacking the constriction. *L.* (*T.*) *kingianum* Kossmat, 1895 itself, from southern India, may be assigned to *Saghalinites* for its wide umbilicus (40–45% of D), but the Patagonian species is as involute and as narrowly umbilicate (33% of D) as *T. popetensis*. Anyhow, *T. popetensis* and the Patagonian form show a seemingly intermediate feature between typical *Tetragonites* and *Saghalinites*.

Occurrence:–The described specimen is from the Fukiyose Bed of Kiyohama-I, upper part of the Zone of *Sphenoceramus schmidti*.

Genus *Pseudophyllites* Kossmat, 1895

Type species:–*Ammonites indra* Forbes, 1846 (original designation).

Remarks:–The diagnosis, the distinctions and relations with other genera and the occurrence of this genus have been recently given by Kennedy and Klinger (1977b, p. 180) whom

we follow.

The specimens from the Soya area are poorly preserved and mostly small. An example of moderate size is described below.

Pseudophyllites indra (Forbes, 1846)

Pl. 21, Fig. 5

1846. *Ammonites indra* Forbes, *Trans. Geol. Soc. London*, ser. 2, vol. 1, p. 105, pl. 11, fig. 7.
1977. *Pseudophyllites indra* (Forbes), Kennedy and Klinger, *Ann. S. Afr. Mus.* vol. 73, pt. 7, p. 182, figs. 19A–F, 20–22 (with full list of synonymy).

Material:–MNH. 231, collected by T. Miyauchi at loc. W7A.

Description:–This specimen is incomplete and somewhat distorted but shows characteristic features. Its approximate dimensions are as follows:

D (restored)	U	H	B (deformed)	B/H
110	18 (.16)	61 (.55)	50 (.45)	0.82

It is wholly septate and must have been fairly large when the body-chamber was preserved. It is involute and narrowly umbilicate. Its whorl is somewhat higher than broad, broadest somewhat above the umbilical shoulder, with rather flat convergent flanks and a narrowly rounded venter. The umbilicus is small, deep and conical with a sloping wall and an abruptly rounded shoulder.

The surface is nearly smooth. The growth-lines on the partly preserved test show a gently backward curve on the ventrolateral part.

Suture is deeply and finely incised, with subphylloid terminals of folioles. It is of typical *Pseudophyllites* pattern.

Comparison:–On the basis of the described characters, this specimen is identified with *P. indra*. It is closely similar to a fairly large example of this species from South Africa, figured by Kennedy and Klinger (1977b, figs. 20–21).

Other smaller specimens from the same and nearby localities may be immature examples of the same species.

Occurrence:–In a calcareous nodules of green dark grey sandstone at loc. W7A, dredged from the bottom of the Soya harbour. The rock is probably assigned to the member with *Schlueterella kawadai*.

Pseudophyllites cf. *P. teres* (van Hoepen, 1920)

Pl. 21, Fig. 4; Pl. 23, Figs. 4–5

Compare:–

1920. *Tetragonites teres* van Hoepen, *Ann. Trans. Mus.*, vol 7, p. 144, pl. 25, figs. 1–2.
1977. *Pseudophyllites teres* (van Hoepen); Kennedy & Klinger, *Ann. S. Afr. Mus.*, vol. 73, p. 187, figs. 23–24 (with synonymy list).

Material:–MNH. 207 (Pl. 23, Fig. 4) and MNH. 208 (Pl. 23, Fig. 5; Pl. 21, Fig. 4) excavated from Soya harbour (W7A), T. Miyauchi Coll.

Dimensions:–

Specimen	D	U	H	B	B/H
MNH. 207*	57.0 (2)	13.0 (.23)	23.5 (.41)	22.0 (.39)	0.94
MNH. 208*	55.0 (1)	14.0 (.25)	22.5 (.41)	23.5 (.43)	1.04

* meaaured on somewhat deformed specimen without restoration.

Descriptive remarks:–These two specimens have a somewhat wider umbilicus for *Pseudophyllites* and the umbilical wall is subvertical. The flanks are gently convex or rather flattened and subparallel.

The surface is nearly smooth with only fine striae which show a distinctly forward inclination around the umbilicus, are gently prorsiradiate on the main part of the flank, sweep gently backward on the ventrolateral shoulder and cross the venter nearly radially with a slight backward sinus.

Although the specimens are distorted, they are probably referable to *P. teres* rather than to *P. indra* (juvenile).

Generally, well marked constrictions are absent in *Pseudophyllites*, but occasionally a faint constriction like depression accompanied by a slight elevation may occur. This feature is seen in the fine illustration of Kennedy & Klinger (1977b, fig. 19F) of *P. indra* and a Canadian example (Usher, 1952, pl. 3, fig. 11) (plaster cast GK. H9522) of the same species. A similar faint constriction-like depression is discernible near the preserved end of our two specimens.

Occurrence:–The two specimens are in one and the same rock excavated at Soya harbour probably from the bed with *Schlueterella kawadai*.

Family Gaudryceratidae Spath, 1927

Genus *Gaudryceras* de Grossouvre, 1894

Type species:–*Ammonites mitis* von Hauer, 1866 (subsequent designation of Boule, Lemoine and Thevénin, 1906).

Remarks:–Kennedy and Klinger (1979, p. 12) have recently given the diagnosis of this genus, distinctions from allied genera and other comments. We feel it necessary to give additional or revised remarks.

Speaking generally, the well known species of *Gaudycreas* show long stratigraphic ranges in the lower half of the Upper Cretaceous up to somewhere in the Campanian. In the Campanian and the Maastrichtian times the differentiation seems to have occurred more remarkably in this genus and some of the diverged species show comparatively shorter stratigraphic ranges. This must be examined by further careful field works, but *G. hamanakense* Matsumoto et Yoshida, 1979, *G. izumiense* Matsumoto et Morozumi, 1980, *G.* sp. nov. (unnamed), preliminarily mentioned by Matsumoto (1981, p. 289, pl. 46, figs. 3–5; pl. 47, figs. 3–6) and probably *G. denmanense* Whiteaves, 1879 may be such examples in the North Pacific region. A new species described below may also be an example. We reserve, however, more compreprehensive and clearer remarks for another occasion.

Gaudryceras mamiyai sp. nov.

Pl. 24, Fig. 1

Material:–Holotype, GK. H5974, obtained by T. Miyauchi from a calcareous nodule of

greenish dark grey sandy siltstone in a pile of dredged rocks at a point immediately northeast of the fishery harbour of Kiyohama-II. Paratypes, MNH. 185 and MNH. 186 obtained by H. Honma and T. Miyauchi from the floated calcareous nodules on the west side of the northern end of the newly constructed jetty (break-water) at Kiyohama-II.

Diagnosis:–Mature shell rather polygyral and of moderate size. Coiling at first evolute, becoming moderately involute later with expansion of moderate rate. Umbilicus of moderate width. Septate whorl subrounded in section, nearly as high as broad in its late part, with rounded venter, gently convex flanks, abruptly rounder umbilical shoulders and steeply inclined to nearly vertical umbilical walls. Adult body-chamber at least 200° in length, somewhat higher than broad and subelliptical in section.

Periodic constrictions fairly frequent on phragmocone, well marked on the inner whorls of young stages, becoming rather indistinct on the last 240° of the septate whorl. Besides the major ribs which are associated with the constrictions, the septate whorl ornamented with fine, narrowly raised subcostae, which are flexiradiate, normally alternately long and short, without or with occasional appearance of branching, and separated by wider interspaces.

Adult body-chamber ornamented with frequent major ribs and narrow, sharply raised subcostae. The major rib typically superimposed by two subcostae, one of which more elevated and coarser than the other branched or inserted one. The subcostae on the body-chamber more distinct and separated by wider interspaces than those on the phragmocone. Two to four subcostae in each interval of the major ribs. The two kinds of ribs flexiradiate on the body-chamber as on the phragmocone, running nearly radially on the umbilical wall with a slightly concave curvature, bent fairly strongly forward at about the umbilical shoulder and then curved slightly backward to extend nearly radially on the main part of flank and again curved gently forward at about the rounded ventrolateral shoulder, crossing the venter with gentle projection.

Suture as in previously known species of *Gaudryceras*.

Dimensions:–

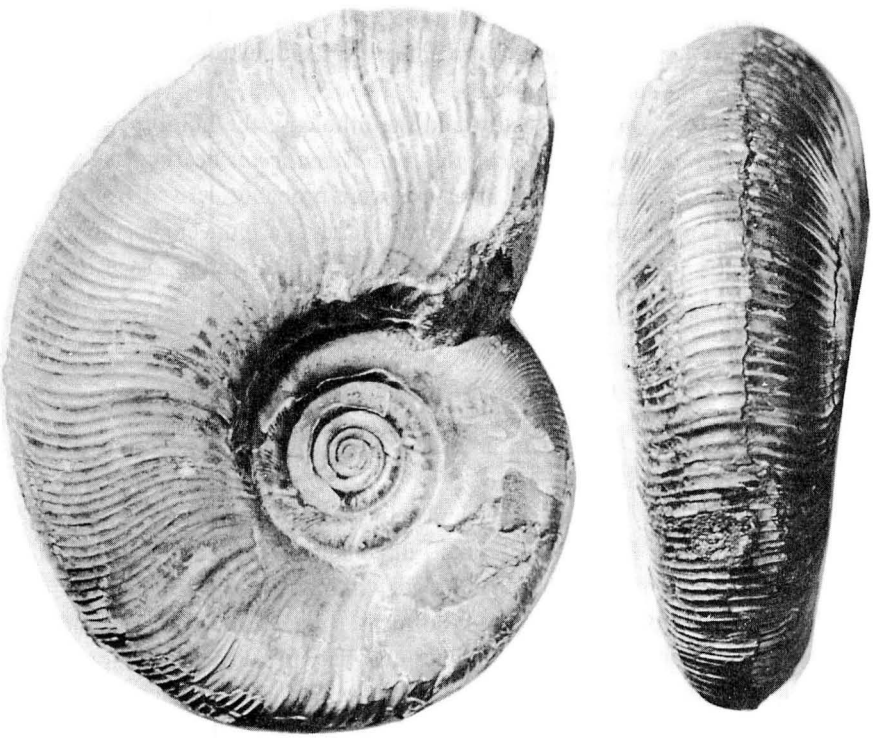
Specimen	D	U	H	B	B/H
Holotype	~121	39.5 (.33)	~50 (.41)	~40 (.33)	0.8
" (last septum)	~ 73	26.4 (.36)	29.5 (.40)	30.0 (.41)	1.01
For comparison: *G. tenuiliratum*					
GK. H2215	97.0	32.0 (.33)	~41.0 (.42)	~36 (.37)	0.88
" (last septum)	~ 55	21.0 (.38)	19.5 (.35)	19.5 (.35)	1.0

Description:–The body-chamber is somewhat deformed secondarily in the holotype as in the two paratypes, of which MNH. 186 is 115 mm and MNH. 185 is about 100 mm in diameter. The major ribs are 14 in the body-chamber (about 200°) of the holotype, 12 in that (180°) of MNH. 186 and 11 in that (200°) of MNH. 185. In other words, MNH. 186 shows nearly the same features as the holotype, whereas MNH. 185 has slightly less frequent major ribs on which 2 to 4 subcostae are superimposed. On each interspace of the major ribs there are 2 to 3 subcostae in MNH. 186 as in the holotype and 4 to 5 in MNH. 185.

The phragmocone is well preserved in the holotype but unfavourable in the paratypes.

Comparison and discussion:–This species is allied to *G. tenuiliratum* Yabe, 1903, mainly from the Coniacian and Santonian of Japan and Sakhalin, in the shell-form and the fundamental framework of ribbing as well as suture, but is clearly distinguished by coarser, more

widely separated subcostae. The subcostae on the surface of inner whorls of *G. tenuiliratum* are so fine and so weak that they are scarcely or very feebly perceptible on the iternal mould. Therefore, they may be called lirae by some authors. The branching and intercalation of the subcostae are more frequent on the phragmocone of *G. tenuiliratum*. In the present species



Text-fig. 8. *Gaudryceras tenuiliratum* Yabe.
Lateral and ventral views of a typical example, GK. H2215, from the Santonian of the Naibuchi area. Kyushu Univ. (H. Sano) photo. Scale bar = 10 mm.

the subcostae are distinct even on the internal mould and their branching occur very infrequently. The frequency of constrictions in the phragmocone is moderate (5 per whorl on an average) in *G. tenuiliratum* but higher (about 7 or 8 per whorl) in the present species. On the adult body-chamber the subcostae of this species are distinctly coarser, more elevated and separated by wider interspaces than those of *G. tenuiliratum* and especially the sharply elevated subcostae on the major ribs of this species are diagnostic.

Apart from the hypothetical interpretation of Hirano (1978) that *G. tenuiliratum* may be transient polymorphic variety of *G. denseplicatum* (Jimbo), *G. tenuiliratum* is distinct in itself. The lectotype, i.e. *Lytoceras sacya* of Yokoyama, 1890 (pl. 18, fig. 12), designated by Jones (1963, p. 28) and Matsumoto (1963, p. 29) independently, shows fairly well the diagnostic features in both the phragmocone and the body-chamber, although its body-chamber is secondarily compressed. *G. tenuiliratum* in the description of Yabe (1903) seems to have been confused with some forms of *G. denseplicatum*. As this is not the place to give the re-

definition, a typical example of *G. tenuiliratum* in the Kyushu University Geological Collections, from loc. N182f, Zone Mh6β of Matsumoto (1942), is illustrated here (Text-fig. 8) for comparison with the present species.

G. tenuiliratum of Jones (1963, p. 26), from the Zone of *Pachydiscus kamishakensis* near the boundary of Campanian and Maastrichtian in Alaska, is not identified with the named species. One of the illustrated specimens (Jones, 1963, pl. 10, figs. 1–3) is similar to the lectotype of *G. denmanense* (Whiteaves) (see Usher, 1952, pl. 4, fig. 1) and the other (Jones, 1963, pl. 9, figs. 1–3) somewhat resembles the present species, but without seeing the specimens we hesitate to conclude the specific identity.

Occurrence:–Judging from the locality and the lithology, the holotype is certainly from the bed with *Schlueterella kawadai* below the *Metaplacenticeras*-bearing bed in the coastal belt of Kiyohama-II, Soya area. The two paratypes were probably derived from the same bed.

Etymology:–This species is dedicated to Rinzo Mamiya, a pioneer geographer, who sailed off to Sakhalin in 1808 for a geodetic work from the historical landing place close to its type locality.

Genus *Zelandites* Marshall, 1926

Type species:–*Zelandites kaiparaensis* Marshall, 1926, (original designation).

Synonymy:–*Varunaites* Shimizu, 1926.

Diagnosis:–Shell in early growth-stage similar to that of *Anagaudryceras*, expanding with high ratio in whorl-height. Mature shell small, discoidal, involute and narrowly umbilicate. Whorl in late growth-stage much higher than broad, with narrowly arched venter. Constrictions frequent and well marked on internal mould, normally (but not always) prorsiradiate. Surface of shell nearly smooth, but for fine growth-lines or striae. Besides constrictions, fine furrows may be discernible on the body-chamber of some species. Suture with the same formula as that of *Gaudryceras*, but numerous auxiliary elements aligned on a gradually descending line. Major elements deeply incised, with narrowed stems; L may be longer than E and sometimes modified to be asymmetric.

Remarks:–For the general account of *Zelandites*, see Marshall (1926), Matsumoto (1938b, 1959c) and Kennedy & Klinger (1979).

Distribution and age:–Circum-Pacific region; also areas facing the Cretaceous Indian Ocean and the Tethys Ocean. Albian to Maastrichtian.

Zelandites kawanoi (Jimbo, 1894)

Pl. 17, Fig. 3

1894. *Desmoceras kawanoi* Jimbo, *Palaeontol. Abh.*, N. F., vol. 2, no. 3, p. 174 (28), pl. 17 (1), fig. 7.
1903. *Gaudryceras kawanoi* (Jimbo); Yabe, *Jour. Coll. Sci.*, Imp. Univ. Tokyo, vol. 18, art. 2, p. 41.
1938. *Zelandites kawanoi* (Jimbo); Matsumoto, *Japan Jour. Geol. Geogr.*, vol. 15, p. 143, pl. 14, figs. 3, 4.
1963. *Zelandites kawanoi* (Jimbo); Matsumoto *in* Matsumoto (ed.), *A Survey of Fossils from Japan Illustrated in Classical Monographs*, p. 43, pl. 60, fig. 7.

Holotype:–UMUT. MM7509 (=GT. I-97) (by monotypy), from Tshashikots in Ikandai, Urakawa area, southern central Hokkaido.

Material:–MNH. 153 and MNH. 154 from Kiyohama-II.

Description:–This specimen is undoubtedly identified with *Z. kawanoi* in the small involute shell, fairly narrow umbilicus, high whorl, elongated subelliptical section of the body-chamber with the maximum breadth at about the middle of height and the flanks gently inclined toward the umbilicus, weak but frequent, prorsiradiate periodic constrictions which cross the venter with projection, extremely fine growth-striae or lirae with periodically marked disjunction (arrest of growth?) on the surface of the body-chamber and the *Zelandites* type suture, in which L is somewhat but not much deeper than E in the late growth-stage.

The illustrated specimen MNH. 153 (Pl. 17, Fig. 3) has the last septum at D = 35 mm and its body-chamber is at least as long as 200°, although partly destroyed. The restored shell would be about 60 mm in diameter. This may be one of the largest specimens of *Z. kawanoi*. Incidentally, the holotype is much smaller than this specimen and probably immature.

Dimensions:–

Specimen	D	U	H	B	B/H
MNH. 153	40.0	10.5 (.26)	18.0 (.45)	12.4 (.31)	0.69
" (−90°)	34.8	9.7 (.28)	15.6 (.45)	11.3 (.32)	0.72
Holotype	23.0	7.0 (.30)	10.0 (.43)	7.5 (.33)	0.75

Occurrence:–Kiyohama-II, probably from Member G or H above the Zone of *Sphenoceramus schmidti*. Deformed specimens of *Saghalinites* sp. are embedded in the same nodule of greenish, fine-sandy calcareous siltstone.

Judging from the available locality records, *Z. kawanoi* ranges from the Santonian (K5b) to the middle of Campanian (K6a2) in Hokkaido and Sakhalin. According to Dr. Y. Kanie (in *litt.*, 13 April, 1983) *Z. kawanoi* occurs in Member U1β (upper part) and Member U2 (lower part) of the Urakawa area.

Family Turrilitidae Gill, 1871
Subfamily Nostoceratinae Hyatt, 1894

In the Soya area we have not yet found unmistakable examples of the Nostoceratinae, such as *Nostoceras* Hyatt, 1894 and *Didymoceras* Hyatt, 1894. This may be due to our collection failure but may imply some peculiarity in facies. The collected heteromorpha from this area are mostly those uncoiled in a plane or at least nearly so and not those of turrilitoid shape. It is difficult for us to classify adequately these nearly plane forms. In other words some of them could be referred to the Anisoceratidae or the Hamitidae, unless their complete forms or ontogenetic developments and their phylogenetic origins were made clear. Our knowledge on the heteromorph ammonids is insufficient. The definition and the scope of each genus is different between authors. Under these circumstances, the systematic assignment in this paper may be tentative. We will, however, describe the observed facts as they are and discuss to some extent on available evidence.

Genus *Schlueterella* Wiedmann, 1962

Type species:–*Ancyloceras pseudoarmatum* Schlüter, 1872 (original designation).

Diagnosis:–Shell uncoiled nearly in a plane. Straight or gently arcuate long shaft pre-

dominant in the main part, ending in hook. U-curved and/or gently arcuate part(s) exist also in earlier growth-stage(s).

Shell ornamented with annular ribs and quadrituberculate periodic major ribs. Tubercles typically spinose, on either side of siphonal zone or at ventrolateral shoulders and on the flanks, where minor ribs are normally looped. In some species the major ribs may be indistinct or undeveloped but the tubercles occur periodically.

Suture quadrilobate; E, L, U and intervening saddles bifid, with expanded branches and narrowed stems; I small and trifid or pointed. All the elements finely and deeply incised.

Discussion:–Wiedmann (1962) establisehd *Schlueterella* as a subgenus of *Neocrioceras* Spath, 1921, but its type species was based on incomplete fragmentary specimens and its true shape was not clear.

Crioceras spinigerum Jimbo, 1894, the type species of *Neocrioceras*, shows distinctly a crioceratoid shape, as exemplified by a number of specimens in subsequent collections as well as the holotype (Jimbo, 1894, pl. 24, fig. 1). On the other hand, in *S. pseudoarmatus* and its allied species (*S. densiornatus* Collignon, 1969, *S. tenuiannulatus* Collignon, 1969 and *S. kawadai* described below), the strictly or nearly straight long shaft predominates with a U-curved part or hook at the end and probably at some earlier stages. The resemblance between *Shlueterella* and *Neocrioceras* is in the mode of ornamentation that periodic major ribs have four tubercles where some of the minor ribs are looped. The disposition (opposite or alternate or otherwise) of the ventral tubercles is variable in both genera and cannot be a criterion to distinguish them.

Schlueterella resembles *Pseudoxybeloceras* Wright et Matsumoto, 1954 in that they both have straight shafts and U-curved parts and also four rows of tubercles. *P. quadrinodosum* (Jimbo, 1894) (p. 39, pl. 7, figs. 3–4; Wright & Matsumoto, 1954, figs. 9–12; Matsumoto, 1977a, p. 345, pl. 57, fig. 2; pl. 61, fig. 4), the type-species of *Pseudoxybeloceras*, has the U-curved parts in both the phragmocone and the body-chamber and the tubercles on both the major and minor ribs. It is at first bituberculate and later quadrituberculate. In *Schlueterella* the four tubercles occur on periodic ribs (typically major ribs) but the ribs on the intervening parts have no tubercle. Consequently, *Christrophoceras* Collignon, 1969 is not a synonym of *Schlueterella* but can be evaluated at least as a subgenus of *Pseudoxybeloceras* or an independent genus allied to *Pseudoxybeloceras*.

Some species which have been assigned to *Neocrioceras* (*Schlueterella*) are, in our opinion, better transferred to *Pseudoxybeloceras*. *N.* (*S.*) *riosi* Wiedmann, 1962 (p. 205, pl. 12, fig. 7), from the Campanian of Spain, and *N.* (*S.*) *multinodosum* (Schlüter, 1872) (p. 106, pl. 32, figs. 1–2; also Wright, 1979, p. 293, pl. 2, figs. 4, 5), from the Turonian of Germany and England, are such examples. Klinger (1976, p. 74) has already pointed out correctly that *N.* (*S.*) *riosi* should be referred to *Pseudoxybeloceras*.

To sum up the above discussion, *Schlueterella* is allied to but separable from *Neocrioceras* and *Pseudoxybeloceras*. It is not yet certain whether it has a close phylognetic affinity with *Neocrioceras* or *Pseudoxybeloceras* or otherwise. The phylogenetic origin of *Schlueterella* is not yet clear. It could have relation with *Anisoceras* of Albian and Cenomanian ages. Wright (1979) described *N.* (*Schlueterella*) under the Anisoceratidae, although we follow Wiedmann (1962) provisionally in assigning *Schlueterella, Neocrioceras* and *Pseudoxybeloceras* to the Nostoceratinae. If the multiple differentiation or the diversity in evolution were stressed, we would be sympathetic with Spath (1953) in his proposal of the subfamily Neocrioceratinae. Anyhow, under the present circumstances explained above, it is better to treat *Schlueterella*

as a genus independent of *Neocrioceras*.

There is a group of species in which whorl is uncoiled in nearly one plane showing loose subelliptical curvatures and the ribs are periodically quadrituberculate with or without looping of ribs. *N.* (*Schlueterella*) *compressum* Klinger, 1976 (p. 74, pl. 33, fig. 5; text-figs. 8j, 10g) (Immel *et al.*, 1982, p. 25, pl. 9, fig. 3; pl. 10, figs. 1–4; pl. 11, fig. 3), from the Santonian of Zululand and Austria, and *Ancyloceras kossmati* Simionescu, 1899 (p. 257, pl. 1, figs. 6–8), from the Senonian of Transylvania (Rumania), are examples. This group is dissimilar to typical *Neocrioceras* nor to *Schlueterella* in that its mode of uncoiling is subelliptical without straight shaft. In view of its loose uncoiling, a new subgenus would be required for it. That group could be ancestral to *Schlueterella* (s. str.), but they might be parallel offshoots from *Neocrioceras* (s. str.). The relationship is, in our opinion, analogous to that between *Glyptoxoceras* Spath, 1925 and *Diplomoceras* Hyatt, 1900 (see discussion in p. 68).

Campanian *Schlueterella* of the Nostoceratinae is regarded here as homoeomorphous to late Albian-Cenomanian *Anisoceras* Pictet, 1854 (see Clark, 1958) of the Anisoceratidae.

Schlueterella kawadai sp. nov.

Pl. 26, Fig. 1; Pl. 27, Figs. 3–4; Pl. 28, Fig. 2; Pl. 29, Fig. 1; Pl. 30, Figs. 1–2: Pl. 31, Fig. 3; Text-fig. 9

1934. *Hamites* cf. *amartus* Sowerby; Kawada *in* Kawasaki, *Report of investigation on the coal-field of Sakhalin*, no. 1, pl. 7, fig. 15; pl. 8, fig. 16.

1938. "*Anisoceras*" *kawadai* Matsumoto (*nom. nud.*), *Proc. Imp. Acad.* Tokyo, vol. 14, p. 193 (listed only).

1942. *Pseudoxybeloceras* (?) *kawadai* Matsumoto (*nom. nud.*), *Mem. Fac. Sci., Kyushu Imp. Univ.*, ser. D, vol. 1, no. 3, p. 167 (listed only).

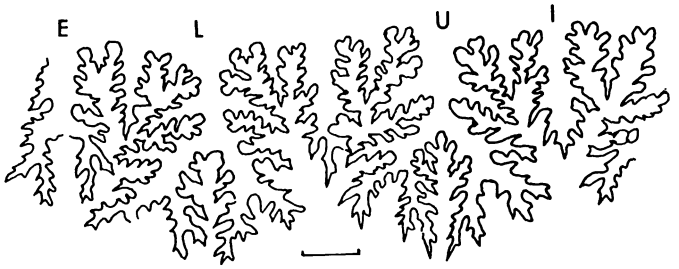
Material:–Numerous fragmentary specimens excavated from a bed under the sea-water of Soya fishery harbour, of which GK. H5978 [MNH. 81] (Pl. 26, Fig. 1) is designated as the holotype.

Paratypes: MNH. 111 (Pl. 30, Fig. 2), MNH. 216 (Pl. 30, Fig. 1), MNH. 211, MNH. 212 (Pl. 29, Fig. 1), MNH. 83 (Pl. 28, Fig. 2), MNH. 215 (Pl. 27, Fig. 3), MNH. 75, 77, 78, 79, 80, 82, 84, 85, 86, 92, 94, 98, 101, 209 and 210. MNH. 215 and 216 have been provided by T. Saheki for this study; others T. Miyauchi Coll.

In addition to the above, the following specimens from the Naibuchi area, South Sakhalin are concerned with the description: GT. I-519 (=UMUT. MM6310) and I-520 (=UMUT. 7672) of M. Kawada's Collection; GT. I-2841, I-2842, I-2843, I-2845 and I-2847 of T. Matsumoto's Coll.; GT. I-1427b (Text-fig. 9) from Togushi, Ishizaki & Sakakura's Coll. Also GK. H5961 from loc. E30 of Wembets-Rubeshbe, Teshio Mountains, collected by T. Shimanuki and donated to Kyushu University through T. Matsumoto.

Diagnosis:–Shell large, consisting of nearly straight or gently arcuate long shaft with subcircular section in the main part followed by a U-curved hook at the end. Another or other hamitoid part(s) existent in earlier stage(s). In the curved part section may be somewhat broader than high with flattened dorsum. Still earlier part gently arcuate.

Numerous ribs, typically vertical to the axis of growh but sometimes oblique forward in lateral view, with periodic major ribs on which there are spinose tubercles in four rows – on either side of the ventral zone and at about mid-flank. On each row the tubercles aligned not strictly straightly but in zigzags (i.e. *chidori-ashi* in Japanese). Spines septate at the basal node and elongated radially around the circular section. A few minor ribs superimposed on each



Text-fig. 9. *Schlueterella kawadai* sp. nov.
Suture-line of GT. I-1427 b from Togushi. (T. Matsumoto *delin.*)

major rib and several minor ribs on each interval of major ones. Some of the minor ribs looped at the tubercles. The tubercles on either side of the siphonal zone are sometimes nearly opposite but not always so even in one and the same specimen.

Suture quadrilobate. E, L, U and two lateral saddles bifid; I much smaller than others and pointed. All the elements deeply and finely incised, leaving much narrowed stems and thus resulting in florid pattern like the sutural elements of *Anisoceras*.

Descriptive remarks:–Although there are numerous specimens, they are more or less fragmentary. Many of them are straight, some (e.g. MNH. 78) are gently arcuate and still others (e.g. MNH. 81, 83, 95, 209 and 216) show a hamitoid curve.

The tapering is very slow in the straight shaft. The longest of the straight shafts is the one which one of us (Miyauchi) saw on the occasion of the excavation. It was at least 100 cm long and 80 mm in whorl-height. Regretably, it was destroyed away later.

The specimens at our disposal are not so long but suggest a fairly large shell. For example, MNH. 111 (Pl. 30, Fig. 2) measures about 30 cm long, H = 88 mm and B = 96 mm (B/H = 1.09) at its mid-length. Its preserved terminal portion tends to bend in hamitoid way. It has no septum and is the body-chamber.

MNH. 216 (Pl. 30, Fig. 1) is another example of the body-chamber which shows distinctly a hamitoid bending. Its terminal arm, about 64.5 mm in whorl-height, is densely ribbed and therefore represents probably a gerontic stage. Its posterior straight shaft measures H = 75 mm and B = 59 mm, but may be secondarily distorted. The extremely prorsiradiate ribbing on its posterior shaft may have some effect of distortion as in MNH. 95.

The U-shaped bending is shown also in some smaller specimens, e.g. MNH. 81 (Pl. 26, Fig. 1), 83 (Pl. 28, Fig. 2) and 209. The first has a subcircular section, with H = 33.5 mm, B = 37.0 mm and B/H = 1.10; the second, in somewhat distorted condition, has H = 25 mm at the curved part. The third, measures H = B = 29.0 mm at the straight part and H = 27.0, B = 29.4 at the curved part. Despite their small size, no suture is preserved in them. They might represent a curved part of an earlier stage well before the long straight shaft of the middle stage but could also be interpreted as the adult body-chamber of a microconch. In the latter case, MNH. 216 and 111 would represent the macroconch of a dimorphic pair. In the former case, the smaller specimens (MNH. 81, 83, 209) might represent a body-chamber of an immature shell. There are examples, MNH. 94 and MNH. 236, of a U-curved septate shell of a moderate size.

There are a few specimens in which the last suture is observed at a certain position of a straight shaft. MNH. 210, a straight shaft of about 20 cm in length, has the last suture at H = 25 mm near (but not at) the preserved anterior end of this fragmentary shaft. This may mark

the beginning of the body-chamber in the microconch. MNH. 212 (Pl. 29, Fig. 1), about 16 cm long, H = B = 52 mm, has no septum and can be interpreted as the straight part of the body-chamber of a microconch. On the other hand, MNH. 92 and MNH. 211 are evidently larger than MNH. 210, with H = 40 mm in MNH. 92 and H = 52 in MMN. 212, but wholly septate throughout the length of about 16 cm. In MNH. 78 the last suture is at H = 65 mm in the middle of gently arcuate long shaft. These specimens may be parts of the macroconchs.

There are very few examples of smaller specimens in the available material. MNH. 215 (Pl. 27, Fig. 3) is an example with H = 9 mm. It is nearly straight and very gently arcuate. It has the characteristic ornaments like those of larger specimens.

Taking all the available lines of evidence into consideration, we are inclined to presume a long hamitoid shape of the shell, with a U-curved part at least in the middle growth-stage and another hook in the body-chamber. We presume the possible existence of the dimorphic pair, micro- and macroconchs, in this species. We need, however, better preserved specimens of especially early growth-stages to know the true state.

The disposition of tubercles in zigzags in each of four rows is characteristic of this species. Owing to this disposition, the long spines are arranged in at least 8 different orientations. This is probably an adaptation to make the protection against enemies more firmly. The spines are normally unpreserved on the internal mould but are excellently preserved in the external mould of favourable specimens.

Comparison:–This species is closely allied to *Ancyloceras pseudoarmatum* Schlüter (1872, p. 99, pl. 31, figs. 1–3; 1876, p. 164, pl. 43, figs. 5–9), from the Campanian of Germany (Mucronaten-Kreide von Darup). That species is again based on fragmentary specimens and its true shell-form is not precisely known. So far as its illustrated specimens are concerned, its similarity to ours in the long straight shaft, gently curved part, hooked part and mode of ornamentation is noted. The distinction of our species is the zigzag dispostion of tubercles in each row. On the average, the ribs are more numerous and denser in our species, but a less densely ribbed variant (e.g. GK. H5961) in our species is similar to the German species with respect to the rib density.

Schlueterella tenuiannulatus (Collignon, 1969) (p. 44, pl. 530, fig. 2089), from near the boundary of Lower and Middle Campanian of Madagascar, has more numerous, much denser and finer ribs than *S. kawadai*. Its tubercles are smaller and the two ventral tubercles are more approximated and the lateral tubercles are in the external part of the flank. Its holotype is a gently arcuate long shaft with a higher ratio of whorl expansion.

The disposition of tubercles in zigzags is shown in some (but not all) specimens of *Neocrioceras* [*Schlueterella* (?)] *compressum* Klinger,1976 (see Immel *et al.*, 1982, p. 25, pl. 10, figs. 2–3), from the Santonian of Zululand and Austria (and also Japan – not yet described), but that species has compressed whorls which are uncoiled in loose elliptical form. In that species tuberculated ribs occur more frequently in the late growth stage.

Occurrence:–Common in a particular bed (Member H) of silty green sandstone below the dark coloured siltstone characterized by *Metaplacenticeras subtilistriatum* in Soya harbour and its extension in Kiyohama-I. In the Teshio Mountains, loc. E30 in the Wembets-Rubeshbe below the prolific part of *M. subtilistriatum*.

In South Sakhalin (Saghalien), locs. N-100b4, N-222, N. 465, Unit Rby, and loc. N-420d, Unit Ray3 of the Ryugase Group in the Naibuchi area (Matsumoto, 1942); Togushi Sandstone of Nishinoturo peninsula.

Genus *Parasolenoceras* Collignon, 1969

Type species:–*Parasolenoceras splendens* Collignon, 1969.

Remarks:–In Part 1 one of us (T. Matsumoto) has introduced a new species (*P. tomitai*) of *Parasolenoceras*, which is fairly allied to the type species in having uniformly narrow ribs and small tubercles. We describe below an example in which major ribs with larger tubercles occur periodically in addition to the narrower ribs with smaller tubercles. It is provisionally assigned to *Parasolenoceras*.

Idiohamites (?) *oronensis* Lewy, 1969 (p. 127, pl. 3, figs. 10–11) and *I.* (?) *circularis* Lewy, 1969 (p. 128, pl. 3, fig. 9; text-fig. 3), from the Upper Campanian of Israel, and *Hamites* (?) *taylorensis* Adkins, 1929 (p. 209, pl. 6, figs. 12–13), from the Campanian Taylor Formation of Texas, have weak major ribs with tubercles at the ventrolateral shoulders, where minor ribs are looped. They have no tubercle on minor intervening ribs nor on the flanks. This group of ammonites is distinguished from *Idiohamites* Spath, 1925 in that the latter has a pair of ventral tubercles jointed only by single rib and is distinguished from *Parasolenoceras* in that the latter has a pair of tubercles on every rib. Therefore, we propose **Lewyites gen. nov.**, with *I.* (?) *oronensis* Lewy as its type species for this group. The generic diagnosis may be written as follows: Loosely elliptical or arcuate shell of hamitoid shape, with oval to circular cross-section. Annular ribs periodically somewhat strengthened on the ventral part and provided with a pair of ventrolateral (or ventral) major tubercles where minor ribs are looped. No tubercle on intervening minor ribs. Suture quadrilobate, with bifid saddles and lobes, except for small I.

Parasolenoceras periodicum sp. nov.

Pl. 28, Fig. 1; Pl. 31, Fig. 1

Material:–Holotype GK. H5979 [MNH. 235] and paratype MNH. 220 from Soya harbour (W7A). Another comparable specimen, MNH. 129 from Kiyohama-I. All T. Miyauchi Coll.

Diagnosis:–Shell fairly large, with subrectangular to subelliptical cross-section. Long straight shaft followed by U-curved retroversal hook. Ribs simple, numerous, rather narrow, separated by somewhat wider interspaces; each provided with a small tubercle at the ventrolateral shoulder. Low major rib, which occurs periodically on the ventral part, provided with major ventrolateral tubercle, where two or three minor ribs are looped.

Description:–The holotype is a piece of straight shaft, about 100 mm long, with H = 45.5, B = 34.0 mm (B/H = 0.75) at the middle, and with a very low ratio of expansion. It is unseptate and probably a part of the body-chamber.

The paratype is a U-curved piece, unseptate and somewhat larger than the holotype, with B = 42–46 mm. Probably, it represents the hooked part of the body-chamber succeeding to the straight shaft.

The two specimens both show a subrectangular to subelliptical cross-section, with slightly convex or nearly flat flanks, abruptly rounded to subangular ventrolateral shoulders and a nearly flat or slightly convex venter. The width of the venter between the rows of ventrolateral tubercles is 21 mm in the holotype and 27 mm in the paratype.

Minor tubercles are small and pointed, whereas major tubercles are somewhat clavate. The periodic major ribs with larger tubercles seem to occur at irregular intervals, only one in the

100 mm length of the holotype, but three on the strongly curved part and one more with a wider interval on the less curved part of the paratype.

MNH. 129 (Pl. 31, Fig. 2), from the lower stratigraphic level than the types, is a small septate piece of straight shaft, about 60 mm in length with H = 16.2, B = 14.0 mm (B/H = 0.86) at the mid-length. Its mode of ribbing and tuberculation is essentially similar to that of the holotype. There is no lateral tubercle, but for occasional looping of the ribs on the flank without tubercle. The last feature might be due to injury. Its major low ribs with major ventrolateral tubercles occur at shorter (but irregular) intervals than in the holotype. The outline of its cross-section is somewhat broader and more elliptical than that of the holotype. The width of the venter between the rows of tubercles is 9–10 mm. The suture is fairly deeply and finely incised for this small size. Its internal lobe (I) is fairly deep as in other known species of *Parasolenoceras*.

Comparison and discussion:–The described specimens are fragmentary but show the diagnostic characters which enable us to establish a new species. The long straight shaft followed by a U-curved hook and the presence of a ventrolateral tubercle on every rib would allow us to refer this species to *Parasolenoceras*.

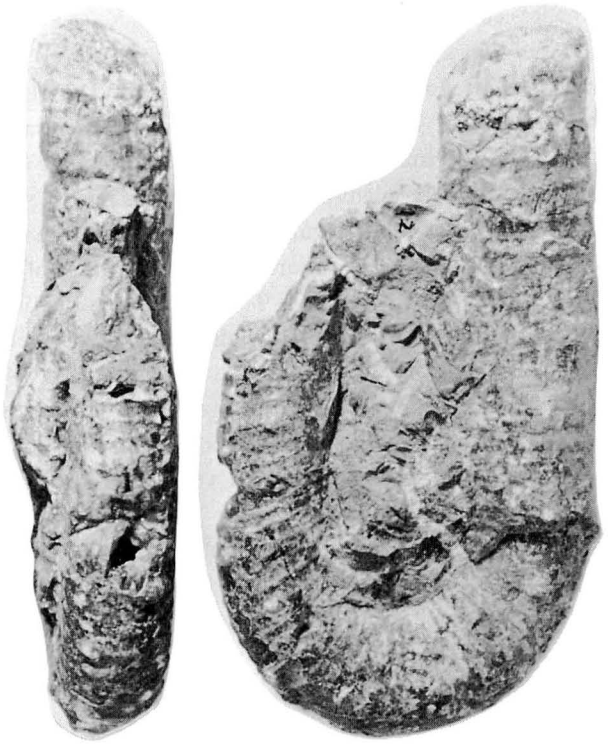
Compared with *P. splendens* Collignon (1969, p. 47, pl. 531, fig. 2092), the type species from the Lower Campanian of Madagascar, this species is still larger and shows a more gently curved U-form. The most distinct criterion is the development of the periodic major ribs with major ventrolateral tubercles at which minor ribs are looped.

In this respect a similarity is searched in the subgenus *Pseudoxybeloceras* (*Christophoceras*) Collignon, 1969, represented by *P.* (*C.*) *ramboulai* Collignon (1969, p. 457, pl. 531, fig. 2093) from the Lower Campanian of Madagascar, but that species has well developed lower ventrolateral (or upper lateral) tubercles on the major ribs and also small tubercles on some of the intervening minor ribs on the same line.

Pseudoxybeloceras lineatum (Gabb), from the Campanian of the Northern Pacific region, has also periodic major ribs, but the development of the lower ventrolateral tubercles seems to be variable and incipient, as judged from the previous descriptions (see Matsumoto, 1959c, p. 162, pl. 40, fig. 1; pl. 41, fig. 1; text-figs. 76–79; also Ward & Mallowry, 1977, p. 613, pl. 1, figs. 1–7). Should this be really so, this plastic species could lead to such species which have periodic major ribs but no lateral (or lower ventrolateral) tubercle at all.

In this connexion, MNH. 129 from the upper part of the *Schmidti* Zone, described above is noteworthy, since it might represent a passage stage in the reduction of lateral tubercles. Furthermore, we have another specimen (MNH. 128) (Text-fig. 10) from the lower part of the *Schmidti* Zone at Ohmisaki, which can be referred to *P. lineatum*. It has clearly the lateral tubercle on each of the periodic major ribs. It consists of two parallel straight shafts connected by a U-curved part. It closely resembles one of the specimens of *P. lineatum* figured by Matsumoto (1959c, pl. 41, fig. 1) but is wholly septate and its later shaft is as large as the lectotype (refigured by Matsumoto, 1959c, pl. 40, fig. 1).

The subgenus *Pseudoxybeloceras* (*Cyphoceras*) Ward et Mallory, 1977 was establisehd on the type species *P.* (*C.*) *lineatum*. It seems fairly difficult to define this subgenus, because *P. lineatum* is so variable as mentioned above. We would regard *Cyphoceras* as synonymous either with *Christophoceras* or with *Parasolenoceras*. Ward & Mallory (1979, p. 611) themselves state that *Christophoceras rambouli* and *Paraslenoceras splendens* are probably to be referred to the subgenus *Cyphoceras*, disregarding the rule of priority.



Text-fig. 10. *Pseudoxybeloceras lineatum* (Gabb).
Two views of MNH. 128 from Ohmisaki. Scale bar: 10 mm.
(Photos by courtesy of Dr. M. Noda)

Pseudoxybeloceras (*Cyphoceras*) *nanaimoense* Ward et Mallory, 1977 (p. 615, pl. 2, figs. 1–3; pl. 3, figs. 1–4), from the Campanian (probably its lower part) of Vancouver Island, has no lateral tubercle. Its ventrolateral tubercles are larger at periodic intervals where minor ribs are looped. The low major ribs on the ventral part corresponding to the major tubercles might have been suppressed in the Nanaimo specimens owing to the secondary deformation. Anyhow, it is considerably similar to our species, but it has denser ribs. Its shafts are longer and its tubercles are more spinose, but there is a problem of preservation about these two characters. Anyhow, we propose to transfer *P.* (*C.*) *nanaimoense* to *Parasolenoceras*.

Occurrence:–The holotype and the paratype are in the excavated rock of Soya harbour, probably came from the bed with *Schlueterella kawadai*. A comparable but not quite identical specimen is from the Fukiyose Member (upper part of the Zone of *Sphenoceramus schmidti*) at Kiyohama-I.

Subfamily Diplomoceratinae Spath, 1926
Genus *Ryugasella* Wright et Matsumoto, 1954

Type species:–*Ryugasella ryugasensis* Wright et Matsumoto, 1954 (original designation).

Diagnosis:–Shell uncoiled in one plane, broadly arcuate in early stage then becoming quite straight, the resulting shape in the main part being that of the Japanese long sword "*naginata*",

but ending at another curve to let the aperture facing obliquely upward.

Ribs dense, annular, prorsiradiate and untuberculate, with occasional constrictions.

Suture IULE, with all the elements bifid, except for trifid I.

Discussion:–As the body-chamber with apertural part has been found (see description below), the generic diagnosis given by Wright & Matsumoto (1954, p. 122) is revised above. There are a few nearly straight or gently arcuate thin specimens which may represent the earliest growth-stage.

Obata & Futakami (1975, p. 103; 1977, p. 25) mentioned that there is a new species of *Ryugasella* from the Turonian of the Manji area, central Hokkaido, which is much larger than *R. ryugasensis* and resembles *Scalarites mihoensis* Wright et Matsumoto, 1954 in some respects. This will confirm the Wright & Matsumoto's (1954a) view that *Ryugasella* may be an offshoot of *Scalarites*, although we await the full description of that new species.

Someone said that *Ryugasella* may be merely an early shaft of *Polyptychoceras* Yabe, 1927, but this is not tenable, although they may have common origin in *Scalarites*. It can be said that *Ryugasella* is homoeomorphus to *Sciponoceras* Hyatt, 1894 of the Baculitidae, but the terminal part of the body-chamber is more distinctly curved in *Ryugasella*.

Ryugasella ryugasensis Wright et Matsumoto, 1954

Pl. 27, Fig. 1

1954. *Ryugasella ryugasensis* Wright et Matsumoto, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 4, no. 2, p. 122, pl. 7, fig. 4; text-figs. 7, 13.

1959. *Ryugasella ryugasensis* Wright et Matsumoto; Matsumoto, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, Spec. vol. 1, p. 169, pl. 37, fig. 4.

Material:–MNH. 167 and MNH. 201 (Pl. 27, Fig. 1), collected by T. Miyauchi from loc. W4C, Ohmisaki. The holotype, UMUT. MM. 6583 (=GT. I-2862) (Wright & Matsumoto, 1954, pl. 7, fig. 4) from South Sakhalin is also reexamined.

Description:–MNH. 167 is a fragmentary straight shaft, nearly as large as the holotype and provided with oblique (prorsiradiate) ribs and a periodic constriction. It is about 40 mm long and its three quarters are septate and the last quarter is a portion of the body-chamber. Its section is subcircular. Its last suture is at H = 5.2 mm and is similar to the figured one of the holotype (Wright & Matsumoto, 1954, fig. 13E).

MNH. 201 is larger than MNH. 167, with H = B = 8.0 mm at its posterior end, about 65 mm in length, nearly straight in the main part and gently curved at the preserved anterior end. It has no septum throughout its length and probably represents the main part of the body-chamber. It has oblique (prorsiradiate) ribs and periodic constrictions. The ribs are sharp headed on the shell but less so on the internal mould. They are fairly dense, numbering 6 within 8 mm distance. A fine riblet may be occasionally intercalated between some of them in the late growth-stage.

Occurrence:–Loc. W4C, Ohmisaki, Zone of *Sphenoceramus schmidti*. Type locality is loc. N18f, horizon Ray$_1$ of the Ryugase Group, Zone of *S. schmidti* in South Sakhalin.

Genus *Diplomoceras* Hyatt, 1900

Type species:–*Hamites cylindraceus* Defrance, 1822 *in* d'Orbigny, 1842.

Diagnosis:–Several parallel or subparallel straight, more or less separated shafts connected by U-curved parts. Section circular or elliptical. Ribs dense, fine, simple, annular, without tubercle, more distinct on outer shell surface and subdued on internal mould. Suture florid; E, L, U and 2 lateral saddles and internal saddle bifid with expanded branches and narrowed stems; I trifid and smaller.

Discussion:–The shell of the early stage was often described as being loose helicoid spire (Wright, 1957, p. L229; Matsumoto, 1959c, p. 165) or uncoiled spirally (Wiedmann, 1962, p. 208), but there is no published illustration of an actual specimen which shows this feature.

Meanwhile, we have seen two small specimens from the Soya area, which show a form similar to that of later growth-stages, as will be described and illustrated below.

Glyptoxoceras Spath, 1925 was included in *Diplomoceras* as a subgenus by Wiedmann (1962) and Klinger (1976), but we prefer to treat them as independent genera. They may have evolved from *Scalarites* Wright et Matsumoto, 1954 in parallel with each other.

G. indicum (Forbes, 1846) (=*Hamites rugatus* of Kossmat, 1895), a well studied species of *Glyptoxoceras*, shows a fairly closed helical spire at the early stage and is later uncoiled subelliptically (see Matsumoto, 1959c, p. 167, pl. 41, figs. 2–6).

We are not, however, convincing whether the above difference in both early and late growth-stages are always kept in every species of *Diplomoceras* and *Glyptoxoceras* or not.

Diplomoceras notabile Whiteaves, 1903

Pl. 27, Fig. 2; Text-fig. 11A

1903. *Diplomoceras notabile* Whiteaves, *Geol. Surv. Canada Mesozoic Fossils*, vol. 1, pt. 5, p. 335, pl. 44, fig. 4.
1952. *Diplomoceras notabile* Whiteaves; Usher, *Geol. Surv. Canada Bull.* 21, p.109, pl. 29, fig. 2; pl. 30, fig. 1; pl. 31, figs. 26, 27.
1953. *Diplomoceras notabile* Whiteaves; Spath, *Falkland Isl. Depend. Surv. Sci. Rept.*, no. 3, pl. 2, fig. 4.
1971. *Diplomoceras notabile* Whiteaves; Collignon, *Atlas des Fossiles Caracteristiques de Madagascar*, fasc. 17, p. 11, pl. 644, figs. 2377–2379.
1980. *Diplomoceras* sp. cf. *D. notabile* Whiteaves; Matsumoto & Morozumi, *Bull. Osaka Mus. Nat. Hist.*, no. 33, p. 23, pl. 16, fig. 3.
1981. *Diplomoceras* sp. cf. *D. notabile* Whiteaves; Matsumoto *in* Taira & Tashiro (eds.): *Geol. Paleont. Shimanto Belt* (for 1980), p. 291, pl. 47, fig. 8; pl. 48, fig. 6.

Material:–MNH. 97 (Text-fig. 11A) and MNH. 149, collected by T. Miyauchi, and MNH. 214 (Pl. 27, Fig. 2) collected by T. Saheki, all from Soya harbour.

Description:–MNH. 149 is a fragmentary straight shaft of 95 m in H and about 20 cm long. Its main part is septate but the body-chamber begins at about this size. It has numerous, fairly dense, annular ribs.

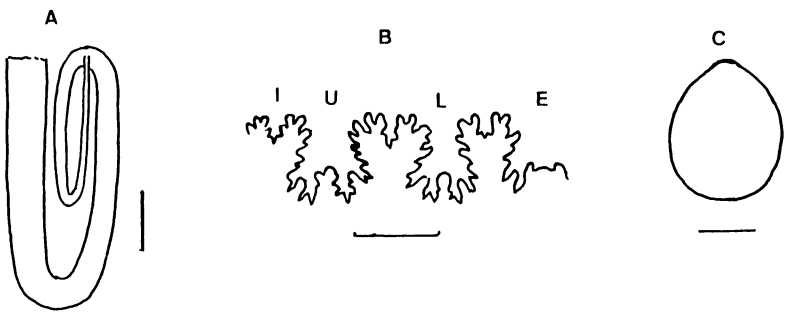
MNH. 97A and MNH. 214 are small, with length of about 22 mm and entire breadth of about 11 mm. Each of them consists of four parallel straight shafts connected by U-curves. The adjacent two shafts are slightly to moderately separated. They are elliptical in section (H > B). The surface looks at first smooth and later finely ribbed.

Comparison and discussion:–MNH. 149 resembles the holotype (Usher, 1952, pl. 29, fig. 2), which is a straight shaft. The U-curved subparallel shafts are shown by GSC. 10065 (whose plaster cast GK. H9569) (Usher, 1952, pl. 30, fig. 1).

As the two small specimens mentioned above occur in the same bed as the larger one and

present similar diagnostic characters, they are regarded as representing the shell of *D. notabile* in early growth-stages. It should be noted that they do not show a spiral form.

As we have not seen the original and the subsequent specimens of *D. cylindraceum* (Defrance *in* d'Orbigny, 1842) (p. 551, pl. 136, figs. 1–4), we are not convincing how to distinguish *D. notabile* from that species. Spath (1953, p. 17) mentioned tht the whorl-section of *D. cylindraceum* is compressed, but d'Orbigny measured H = 43 mm, B = 42 mm (42 mm could be a misprint of 40 mm) and illustrated subcircular (only slightly compressed) section whose dimensions are H = 43 mm, B = 40 mm, hence B/H = 0.93, Whiteaves noted that *D. notabile* has more distinctly defined and narrower ribs than *D. cylindraceum* but suggested that it could be a geographical subspecies of *D. cylindraceum*. We understand provisionally that *D. notabile* has a thickly elliptical section and narrower but well defined ribs, that *D. cylindraceum* has a subcircular section and less raised ribs and that *D. lambi* Spath, 1953



Text-fig. 11. A. *Diplomoceras notabile* Whiteaves. MNH. 97, an immature example. Ribbing omitted from the figure. B, C. *Baculites chicoensis yezoensis* subsp. nov. MNH. 133, suture (B) and cross-section (C). Scale bar: 5 mm. (T. Matsumoto *delin.*)

(p. 17, pl. 2, figs. 1–3; pl. 3, fig. 1), from the Antarctica, has a circular section and more distinctly raised ribs. It is necessary to examine sufficiently numerous specimens from various regions to conclude the distinction as specific or subspecific or otherwise.

The specimen from Azenotani of the Izumi Mountains described by Matsumoto & Morozumi (1980, p. 23, pl. 16, fig. 3) and those from the Nakamura Formation of Kigaru-yama in the Shimanto terrain of Southwest Japan (Matsumoto, 1981, p. 291, pl. 47, fig. 8; pl. 48, fig. 6) are probably identified with *D. notabile*.

Occurrence:–In the greenish grey silty fine-grained sandstone characterized by *Schlueterella kawadai* at Soya harbour.

Family Baculitidae Meek, 1876
Genus *Baculites* Lamarck, 1799

Type species:–*Baculites vertebralis* Lamarck, 1801.

Remarks:–For the general account of the genus *Baculites* see Birkelund (1965, p. 41–44).

Baculites chicoensis Trask, 1856

1856. *Baculites chicoenis* Trask, *Proc. Calif. Acad. Sci.*, vol. 1, p. 92, pl. 2, fig. 2, 2A.

1959. *Baculites chicoensis* Trask; Matsumoto, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 8, no. 4, p. 145, pl. 36, fig. 2; pl. 37, fig. 1; text-figs. 59–63 (with full list of synonymy).
1978. *Baculites chicoensis* Trask; Ward, *Jour. Paleont.*, vol. 53, p. 1148, pl. 1, figs. 3, 4, 8, 9; text-fig. 5E, F.

The specimens from the Soya area represent a new subspecies as described below.

Baculites chicoensis yezoensis subsp. nov.

Pl. 25, Figs. 1–5; Text-figs. 11B, C

1963. *Baculites chicoensis* Trask; Matsumoto and Obata, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 13, no. 1, p. 66, pl. 21, figs. 2, 4; text-figs. 159, 163, 164.

Material:–Holotype of the subspecies GK. H5975 [MNH. 141] (Pl. 25, Fig. 1) from the Fukiyose Bed of Kiyohama-II. Paratypes MNH. 137 (Pl. 25, Fig. 2), MNH. 134 (Pl. 25, Fig. 3), MNH. 133 (Pl. 25, Fig. 4; Text-figs. 11B, C), MNH. 135 (Pl. 25, Fig. 5), MNH. 130 and MNH. 138 from the same bed. Numerous other fragmentary specimens from the same bed. All collected by T. Miyauchi.

Diagnosis:–Similar to *Baculites chicoensis chicoensis* from California but smaller and provided with less distinct or almost imperceptible ventral keel, showing oval cross section.

Description and comparison:–The shell tapering is fairly rapid in the early growth-stage (see MNH. 134) and slow in the late stage (see MNH. 137, MNH. 141). The cross section is oval, being somewhat higher than broad, with variable proportion of B/H ranging from 0.77 to 0.82 in the measured specimens, broadest at the point slightly below (i.e. dorsad from) the mid-flank, and with broadly rounded dorsum, more or less inflated flanks and narrowly rounded venter.

The surface of the shell is nearly smooth, but with faint striae and growth-lirae (see MNH. 137), which show a deep sinus on the dorsal half of the flank, a strong projection on the venter and a much weaker projection on the dorsum.

The suture is fairly finely and deeply incised in the late growth-stage. All the elements, except the small I, are inversed trapezoidal in general outline, forming a dovetail. The median foliole at the bottom of L and U is larger and higher than the lateral folioles on either side of it. The stems of the lobes and saddles show some variation in their breadth. When they are narrow, their outline may look inverse trigonal rather than inverse trapezoidal (see MNH. 130 in comparison with MNH. 133 from the same nodule).

In all the above characters, including the variations, the Soya form is closely similar to the typical form of *B. chicoensis* from the Pacific coast of North America. There are, however, differences in the shell size and the distinctness of the ventral keel. MNH. 137 (Pl. 25, Fig. 2) is one of the largest specimens in the numerous specimens from the Fukiyose Bed. It has the body-chamber and probably represents the adult shell. The holotype (Pl. 25, Fig. 1) seems to represent the preceding late stage of the phragmocone. These specimens as well as others are distinctly smaller than the Californian types (see dimensions).

The venter of the Soya form is narrowly arched and bluntly pointed but the keel is almost imperceptible in the holotype and also in MNH. 137. MNH. 133 and MNH. 135, which are smaller than the above two specimens, have an indistinct keel like elevation bordered by a very faint depressed zone on either side. The ventral keel of the shells (late stage) in the type Chico Creek population of *B. chicoensis* and also from the Nanaimo Group is more distinct and

bordered on either side by better recognizable grooves.

For the above reasons, the Soya form, here described, and also small specimens from the Teshio Mountains, previously described under *B. chicoensis* (see Matsumoto and Obata, 1963), are subspecifically distinguished from the typical *B. chicoensis chicoensis* from California and British Columbia.

Dimensions:–

Specimen	Remarks	H	B	B/H	Distance
MNH. 137	body-chamber	15.6	12.8	0.82	60.0
	last septum	12.6	10.4	0.83	
MNH. 141	septate	11.8	9.3	0.79	
MNH. 136	near last septum	9.8	7.9	0.80	
MNH. 135	weakly keeled	11.0	8.8	0.80	
MNH. 134	immature	7.0	5.4	0.77	
MNH. 133	sept., weakly keeled	12.7	9.9	0.78	
B. chicoensis chicoensis for comparison (from Matsumoto, 1959b)					
LSJU. 8537	body-chamber	22.5	18.0	0.80	55.0
(neotype)	septate	21.5	16.9	0.78	
LSJU. 8538	body-chamber	25.4	20.8	0.81	120.0
"	septate	21.5	16.9	0.78	

Discussion:–*B. chicoensis* is unique among numerous species of *Baculites* in having the dovetail sutural pattern which is similar to that of *Sciponoceras baculoide* (Mantell), *S. kossmati* (Nowak) and *S. orientale* Matsumoto et Obata (see Matsumoto, 1959b, text-figs. 2, 4–6; Matsumoto & Obata, 1963, text-figs. 3, 24, 25, 45–49). This is evidently a homoeomorphy, but may imply something in common in the mode of life. *B. hochstetteri* Liebus, 1902, from the Carpathians, shows a similar but not identical pattern of suture.

The origin of *B. chicoensis* is under debate. Matsumoto and Obata (1963, p. 103, fig. 218) interpreted that it is a keeled offshoot from the root stock of *Baculites* and indicated it diagrammatically as one of the diversified descendants of *B. bailyi* Woods. This could remain as a possible case, although the evolutionary change in sutural pattern is sudden. Ward (1978b) proposed *B. uedae* Matsumoto et Obata as the direct ancestor of *B. chicoensis*. This could be an alternative interpretation, but we hesitate to follow him, becauwe the median foliole at the bottom of L is as small as and overhang by the lateral folioles in *B. uedae*, showing the feature which cannot be ancestral to the larger and higher median foliole at the bottom of L in *B. chicoensis*.

Ward (1978b), furthermore, proposed *B. chicoensis* as a possible ancestor of *B. rex* Anderson, but we hesitate again to follow him, because it seems us unreasonable, if not impossible, to admit that the keel which was acquired by *B. chicoensis* from some keel-less ancestor, was once more lost in its descendant. We hold the view that such a form as *B. hochstetteri* Liebus can be regarded as a possible ancestor of *B. rex*, because they resemble each other in the moderate tapering, the oval cross-section without keel, the smooth surface and the sutural pattern with a reversed trigonal general outline of the elements and because *B. rex* is more advanced than *B. hochstetteri* in the complexity of suture in which the median foliole at the bottom of L is distinctly overhang by the lateral folioles. The former becomes large, whereas the latter is represented by small specimens. *B. hochstetteri* itself was originally

reported from the Carpathians which belonged biogeographically to the Tethys realm, but a form called *B.* sp. aff. *B. hochstetteri* has been reported from the Campanian of Hokkaido by Matsumoto and Obata (1963, p. 63, pl. 20, fig. 4; text-figs. 143, 144, 157), which could be possibly a real ancestor of *B. rex*.

Occurrence:–Common in th Fukiyose Member of Kiyohama-II, which can be assigned to the uppermost part of the Zone of *Sphenoceramus schmidti* in the Soya area.

According to Matsumoto and Obata (1963, p. 67), the same subspecies (*B. chicoensis yezoensis*) occurs in the Zone of *S. orientalis* in the Teshio Mountains. Consequently *B. chicoensis yezoensis* ranges all through the lower half of the Campanian, i.e. in both K6a1 and K6a2, in Hokkaido.

Correlation with the range of *B. chicoensis chicoensis* in California and the Vancouver Islands area is discussed in another page.

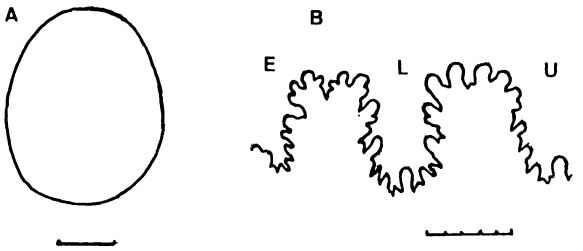
Baculites inornatus Meek, 1862

Pl. 25, Fig. 6; Text-fig. 12

1862. *Baculites inornatus* Meek, *Proc. Acad. Nat. Sci. Philadelphia*, vol. 13, p. 316.
1959. *Baculites inornatus* Meek; Matsumoto, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 8, no. 4, p. 155, pl. 38, fig. 1; pl. 43, fig. 5; text-figs. 72–79 (with full list of synonymy up to 1959).
1963. *Baculites inornatus* Meek; Obata and Matsumoto, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 13, no. 1, p. 78, pl. 22, fig. 1; pl. 24, fig. 6; pl. 26, figs. 4–6; text-figs. 169–170, 187–190.
1978. *Baculites inornatus* Meek; Ward, *Jour. Paleont.*, vol. 52, p. 1151, pl. 1, figs. 1, 2; text-fig. 5G, H.

Material:–MNH. 132 (Pl. 25, Fig. 6; Text-fig. 12A), MNH. 131 (several specimens) and MNH. 140 (several specimens) from loc. W7B, excavated rock of Soya harbour.

Description:–MNH. 132, about 105 mm in length, represents a part of the body-chamber. Its tapering is slow and gradual. It is nearly elliptical in section, higher than broad, with subparallel flanks and the venter somewhat more narrowly rounded than the dorsum. The faintly



Text-fig. 12. *Baculites inornatus* Meek.
A. Cross-section of MNH. 132. Scale bar=10 mm.
B. Suture (part) of MNH. 131a. Scale bar=5 mm.
(T. Matsumoto *delin.*)

preserved growth-lines or fine lirae show a moderately deep asymmetric sinus on the sides, a long linguiform rostrum on the venter and a shorter, broader and more gentle projection on the dorsum. There are some other, more fragmentary specimens which show the same features as above, although some are secondarily compressed.

The septate part is represented by MNH. 131a, b and MNH. 140a, b, c. Its tapering is moderate and the outline of its cross-section is similar to that of the body-chamber. The growth-

lines (well shown on MNH. 140c) are also similar to those of the body-chamber. The pattern of suture is diagnostic. The lobes E, L, U and the saddles between E/L and L/U are broadly rectangular and bifid. E is the broadest and L is somewhat narrower than U. I is small. The incisions are moderate in the late growth-stage (e.g. MNH. 131a; 140a) and rather shallow in the smaller shell of earlier growth-stage (e.g. MNH. 131b, 140b). The folioles have somewhat phylloid terminals.

Comparison:–The above characters conform well the diagnosis of *B. inornatus* Meek described by Matsumoto (1959b) and Ward (1978b) on the specimens from the Pacific coast of North America, including the lectotypes and other examples from the Sucia Islands.

Matsumoto and Obata (1963) did not report this species from Hokkaido, whereas Obata and Matsumoto (1963) described some examples from the Shichi Shale of the Izumi Group in the island of Awaji.

Occurrence:–Common in calcareous nodules (W7B) excavated from the green silty fine-grained sandstone at the bottom of the Soya harbour, which is characterized by *Schlueterella kawadai*.

Baculites kotanii Matsumoto, Hashimoto et Furuichi, 1980

Pl. 25, Fig. 7

1980. *Baculites kotanii* Matsumoto, Hashimoto et Furuichi, *Proc. Japan Acad.*, vol. 56 (B), p. 408, figs. 1, 2.

Holotype:–GLKU. IZ-80001, from the Nakato Shale at Gesho, Izumi Group of the Sanuki Mountains (=Asan Mountains by some authors), Shikoku.

Material:–MNH. 130, collected by T. Miyauchi from loc. W7B.

Description:–This specimen is half septate and the other half is a part of the body-chamber. It is about 55 mm in length, tapering moderately, and compressed elliptical in cross-section, with the following dimensions:

H	B (restored)	B/H	Distance
19.2	11.0	0.57	55
12.5	6.6	0.53	

The shell layer is partly preserved on the body-chamber. The surface of the shell is nearly smooth.

The suture is incisely moderately deeply. The stems of L and the saddles on either side are somewhat narrowed. The median foliole at the bottom of L is distinctly overhang by the lateral fokioles. The folioles end at phylloid terminals.

The above characters conform well with the diagnosis of *B. kotanii* Matsumoto, Hashimoto et Furuichi, 1980.

Remarks:–As has been already discussed by Matsumoto *et al.* (1980), *B. kotannii* is closely allied to *B. eliasi* Cobban (1958, p. 663, pl. 91, figs. 1–11; text-figs. Lf, g, i, j), from the Upper Campanian of the Western Interior of North America, in the compressed elliptical, parallel sided cross-section and the general pattern of suture, but *B. eliasi* shows a very slow tapering in the adult stage and its suture is more finely incised, without keeping phylloid terminals of folioles.

Occurrence:–In a calcareous nodule of dark grey sandy siltstone at W7B, excavated from the bottom of the Soya harbour. The original bed is either the *Metaplacenticeras* bearing dark coloured sandy siltstone or the underlying greenish silty sandstone with *Schlueterella kawadai*, but the former seems to be more probable.

In Shikoku *B. kotanii* occurs at a higher stratigraphic level than *M. subtilistriatum* within the same Nakato Shale.

Baculites sp. aff. *B. menabensis* Collignon, 1969

Pl. 25, Fig. 8

Compare:–

1969. *Baculites menabensis* Collignon, *Atlas des Fossiles Caracteristiques de Madagascar (Ammonites)*, fasc. 15, p. 15, pl. 518, figs. 2036, 2037.

Material:–MNH. 139, collected by T. Miyauchi from Kiyohama-II.

Description:–This is a portion of a septate shell, and somewhat secondarily compressed. The unrestored dimensions are as follows:

H	B	B/H	Distance
18.8	11.2	0.60	45
17.4	10.5	0.60	

The shell shows little tapering and is compressed elliptical in cross-section with nearly parallel flanks.

Distant blunt nodes are on the dorsal part of the flank. They seem to form a weak crescentic arc but the arc is not clearly shown on the other side. Weak rugae are partly discernible on the venter.

The suture is not completely exposed. The saddles and lobes are massive, with wide stems, and the minor incisions are shallow or moderate. Folioles show phylloid terminals.

Compaison:–This single specimen represents a species which was not described previously from Japan. It is, however, too poorly preserved to give a definite name.

In its elliptical section with parallel flanks, distant nodes and sutural pattern, it is allied to *B. menabensis* Collignon, 1969, from the Lower Campanian Zone of *Menabites boulei* of Madagascar, but it shows dissimilar ornamentation. The nodes of *B. menabensis* are slender and longitudinally elongated. This feature is not shown in our specimen. Collignon (1969, p. 15) mentioned the affinity of *B. menabensis* with *B. capensis* Woods, 1906, from the Santonian of South Africa, Madagascar, California and Japan. The longitudinally elongated dorsolateral nodes seem to be characteristic of *B. capensis* and *B. menabensis*, but Matsumoto and Obata (1963, p. 48) have noted that obliquely elongated or crescentric nodes also occur in some of the numerous specimens. Therefore, without examining more and better preserved specimens, we cannot give a definite conclusion.

Occurrence:–In a calcareous nodule of the Fukiyose Member at Kiyohama-II, probably in the upper part of the Zone of *Sphenoceramus schmidti*.

Baculites cf. *B. subanceps pacificus* Matsumoto et Obata, 1963

Text-fig. 13

Compare:–

1959. *Baculites* aff. *B. anceps* Lamarck; Matsumoto, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 8, no. 4, p. 130, pl. 34, fig. 3; pl. 35, fig. 1; text-figs. 42, 43.

1963. *Baculites anceps pacificus* Matsumoto et Obata, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 13, no. 1, p. 59, pl. 20, fig. 3; text-figs. 145, 146, 156.

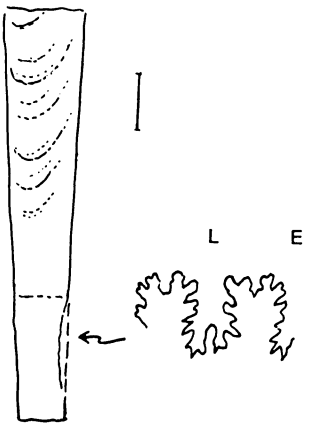
1965. *Baculites subanceps pacificus* Matsumoto et Obata; Howarth, *Bull. Brit. Mus. (Nat. Hist.), Geol.*, vol. 10, no. 10, p. 370.

1978. *Baculites anceps pacificus* Matsumoto et Obata; Ward, *Jour. Paleonti.*, vol. 52, no. 5, p. 1152, pl. 2, figs. 1–4, 8; text-fig. 6.

Material:–MNH. 145, collected by T. Miyauchi at W7B, one of excavated blocks from Soya harbour.

Descriptive remarks:–A straight shell of about 70 mm in length, whose tapering is moderate at earlier stages but less so later. Weak crescent ribs are on the later half. The outline of cross-section is too much modified by secondary deformation, but it is presumed to have been thickly ovoid originally. In the deformed state H is 8 mm at the preserved posterior end and 13 mm at the anterior end.

A part of the suture is exposed, showing subrectangular general outline of L and the outer and inner lateral saddles with less deep incisions, as shown in Text-fig. 13.



Text-fig. 13. *Baculites* cf. *B. subanceps pacificus* Matsumoto et Obata. Sketch of an incompletely preserved example, MNH.145. Lateral view (with scale bar=10 mm and part of suture (magnified). (T. Matsumoto delin.)

The described characters suggest that this specimen is probably identified with *B. subanceps pacificus* Matsumoto et Obata (see above list).

There are some specimens of unfavourable preservation in the excavated blocks from Soya harbour and another from Kiyohama-II. The latter has a thickly ovoid section, with H = 11 mm, B = 9 mm (B/H = 0.82), and shows the same pattern of suture as above. Its surface is so eroded that the ribbing is not clear.

Discussion:–We agree with Howarth (1965) in revising *B. anceps pacificus* to *B. subanceps pacificus*, a geographical subspecies of *B. subanceps* Haughton, 1925 (p. 278, pl. 14, figs. 6–8). Howarth (1965, p. 370) has pointed out the difference in the density of the ribs between *B. subanceps subanceps* (less densely ribbed) and *B. subanceps pacificus* (more densely ribbed). Another criterion may be in the details of the suture that the lateral saddles are broader and more massive in the former. These characters may be variable and it is necessary to examine sufficiently numerous specimens.

Matsumoto (1959b) suggested that *B. fairbanksi* Anderson, 1902 could be of identical species. If truly so, *B. subanceps* would fall in synonymy of *B. fairbanksi*. This should be decided by a restudy of the holotype and topotypes from California in comparison with those from Angola. *B. fairbanksi* is recorded to have occurred with *Metaplacenticeras pacificum*.

Occurrence:–Occasionally found in the dark greenish grey silty fine-grained sandstone

bed in Soya harbour, with *Schlueterella kawadai*. The described specimen is associated with *Neophylloceras* cf. *N. ramosum* and *Pachydiscus soyaensis* in the same rock.

Some Ammonites from the Campanian (Upper Cretaceous) of Northern Hokkaido

Plates

Plates 10 – 31

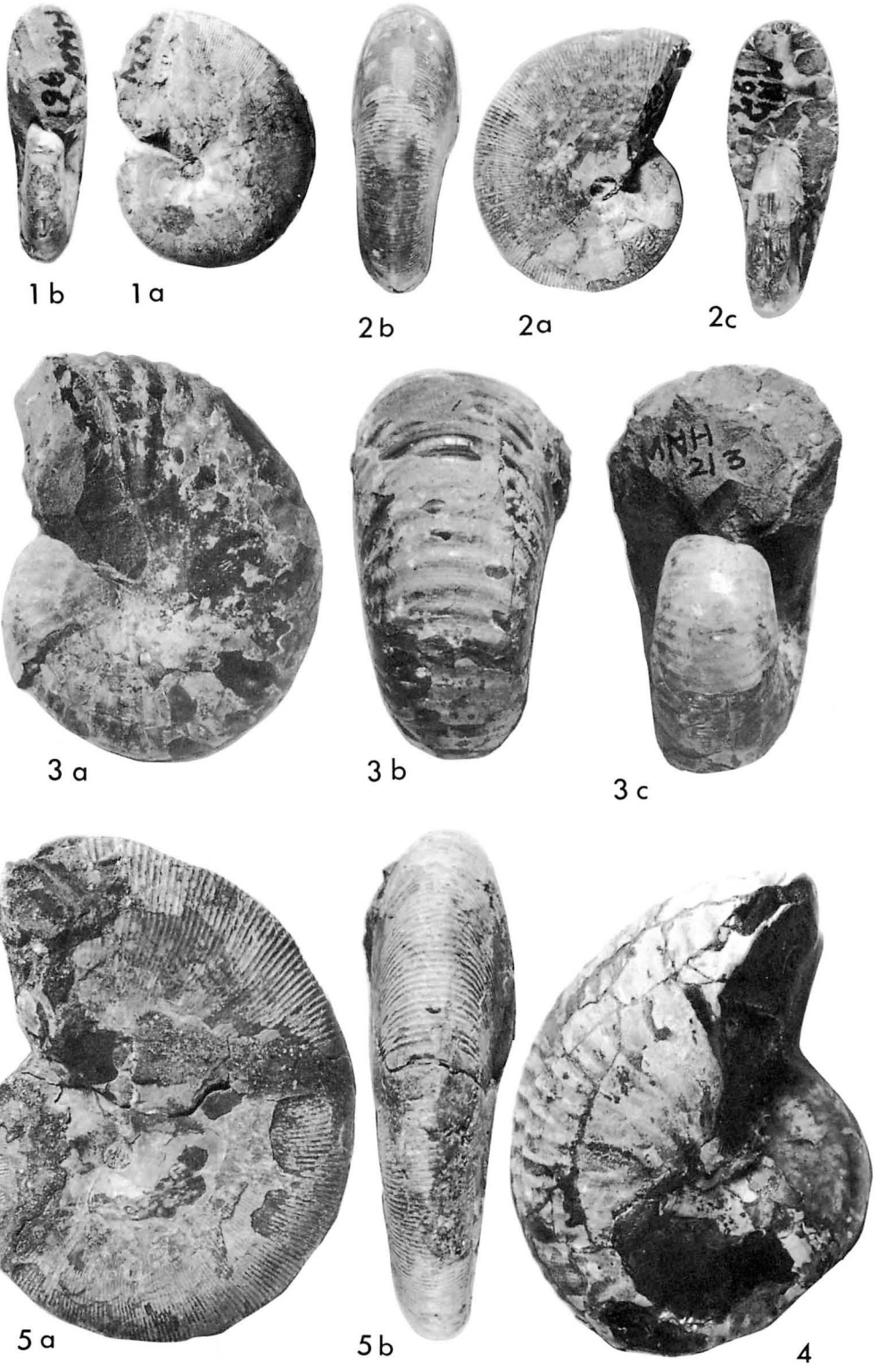
Part 2 (Soya area by T. Matsumoto & T. Miyauchi)

Photos by courtesy of Dr. Masayuki Noda

Plate 10

Explanation of Plate 10

Fig. 1. *Neophylloceras hetonaiense* Matsumoto . . . . . Page 38
MNH. 196 from Kiyohama-I, T. Miyauchi Coll. Lateral (a) and frontal (b) views, x 4/3.
Fig. 2. *Neophylloceras* sp. nov. aff. *N. ramosum* (Meek) . . . . . Page 37
MNH. 197 from Kiyohama-I, T. Miyauchi Coll. Lateral (a), ventral (b) and frontal (c) views, x 1.
Figs. 3, 4. *Phyllopachyceras ezoense* (Yokoyama) . . . . . Page 38
3. MNH. 213 from Kiyohama-I, T. Saheki Coll. Lateral (a), ventral (b) and frontal (c) views, x 1.
4. MNH. 200 from Kiyohama-I, T. Miyauchi Coll. Lateral view of a deformed specimen, x 1.
Fig. 5. *Neophylloceras ramosum* (Meek) . . . . . Page 37
MNH. 198 from Kiyohama-I, T. Miyauchi Coll. Lateral (a) and ventral (b) views, x 1.



T. Matsumoto & T. Miyauchi: Soya Area

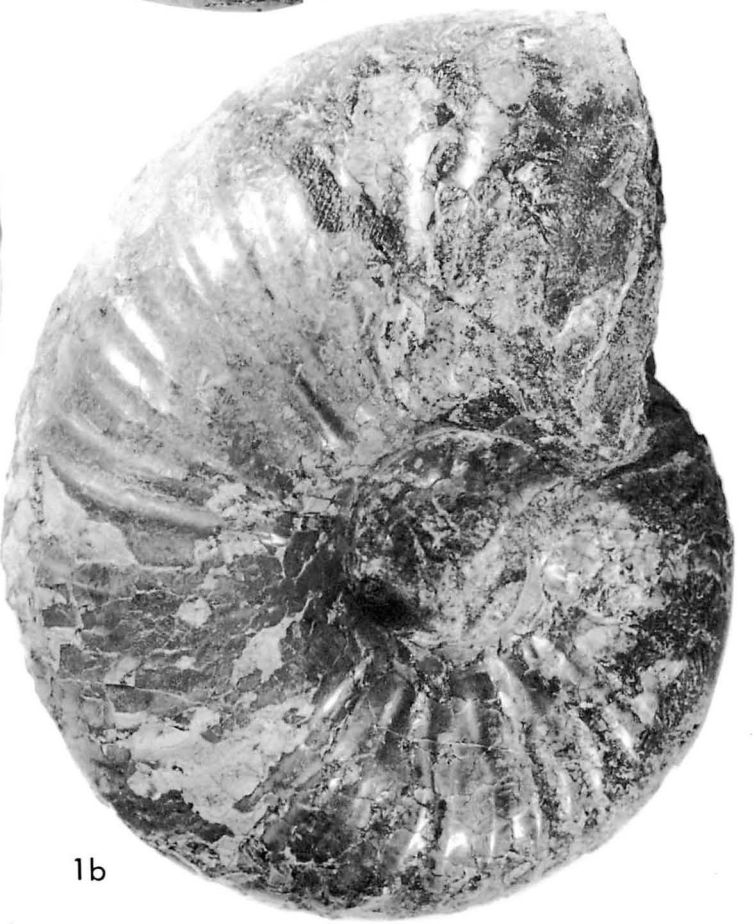
Plate 11

Explanation of Plate 11

Fig. 1. *Pachydiscus soyaensis* Matsumoto et Miyauchi, sp. nov. . . . . Page 41
Holotype, GK. H5972 [MNH. 125], from Soya harbour, T. Miyauchi Coll. Two lateral (a, b) and ventral (c) views, x 1.

1a

1c



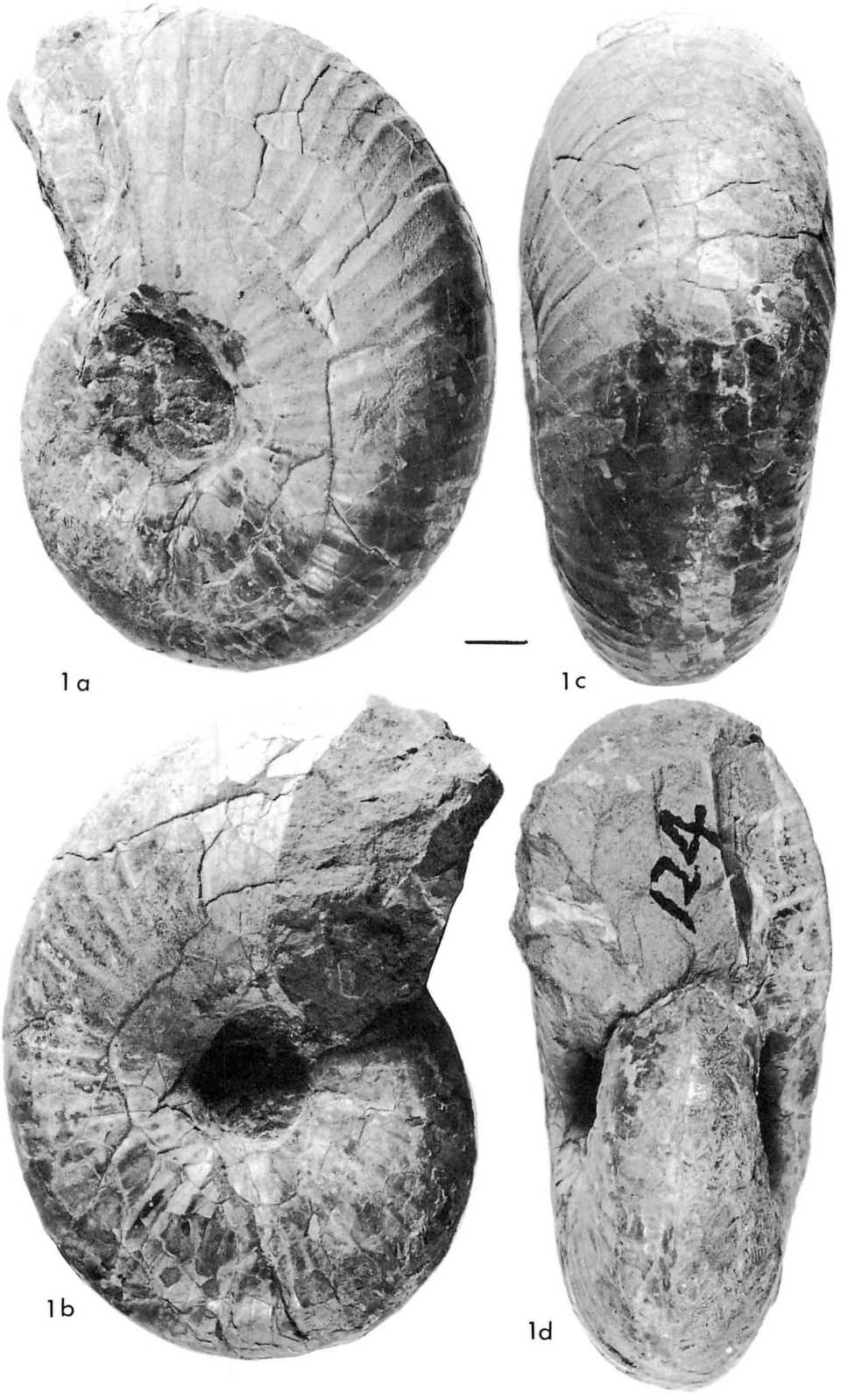
1b

T. Matsumoto & T. Miyauchi: Soya Area

Plate 12

Explanation of Plate 12

Fig. 1. *Pachydiscus soyaensis* Matsumoto et Miyauchi, sp. nov. . . . . Page 41
Paratype, MNH. 124, from Soya harbour, S. Hayama Coll. Two lateral (a, b), ventral (c) and frontal (d) views, x 1. Scale bar = 10 mm.



T. Matsumoto & T. Miyauchi: Soya Area

Plate 13

Explanation of Plate 13

Fig. 1. *Pachydiscus soyaensis* Matsumoto et Miyauchi, sp. nov. . . . . Page 41
Paratype, MNH. 202, from Soya harbour, T. Miyauchi Coll. Two lateral (a, b), ventral (c) and frontal (d) views of an immature example, x 1.

1a

1b

1c

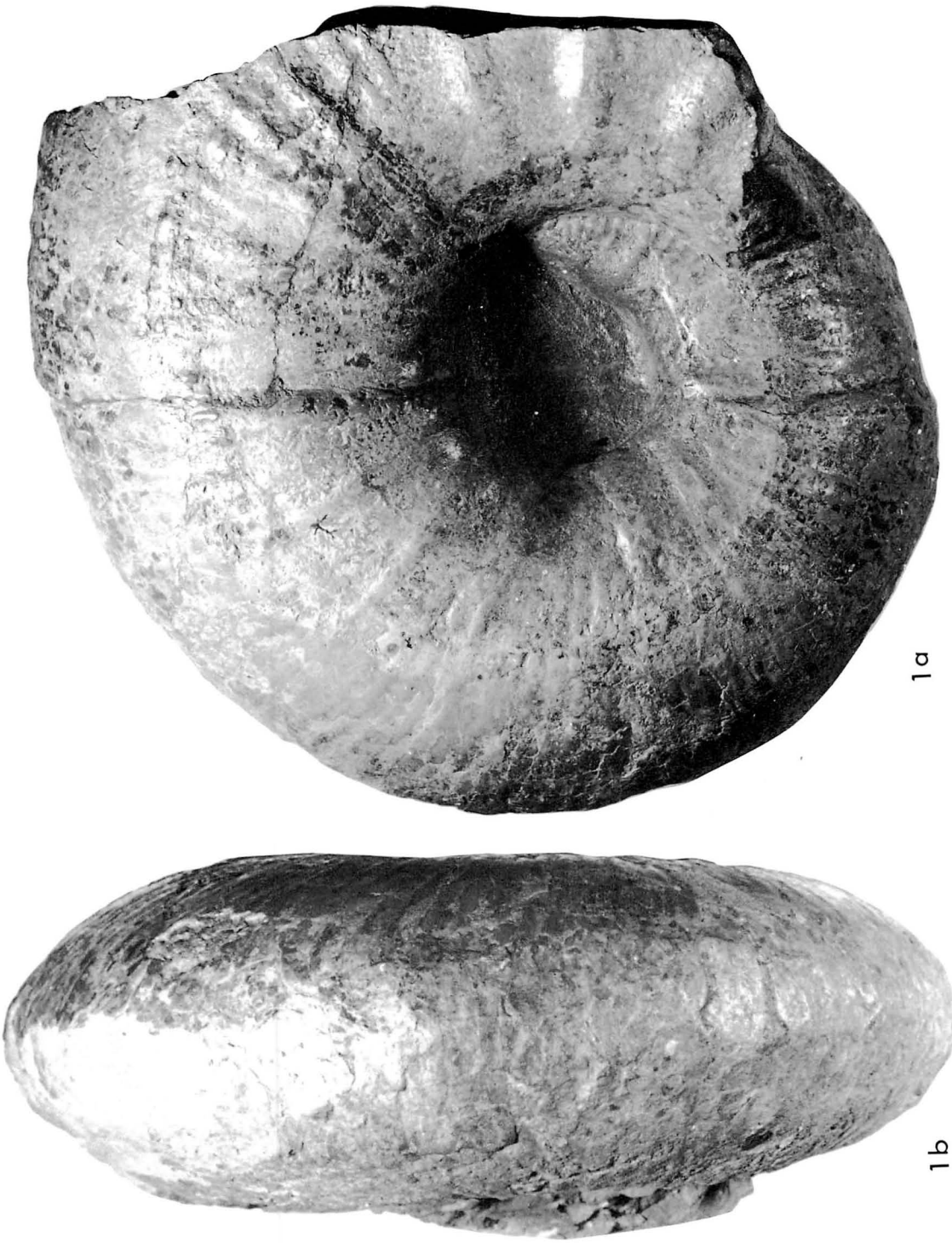
1d

T. Matsumoto & T. Miyauchi: Soya Area

Plate 14

Explanation of Plate 14

Fig. 1. *Pachydiscus sahekii* Matsumoto et Miyauchi, sp. nov. . . . . Page 43
Holotype, GK. H5973, from south of Soya harbour, T. Saheki Coll. Lateral (a) and ventral (b) views, x about 0.5.



1a

1b

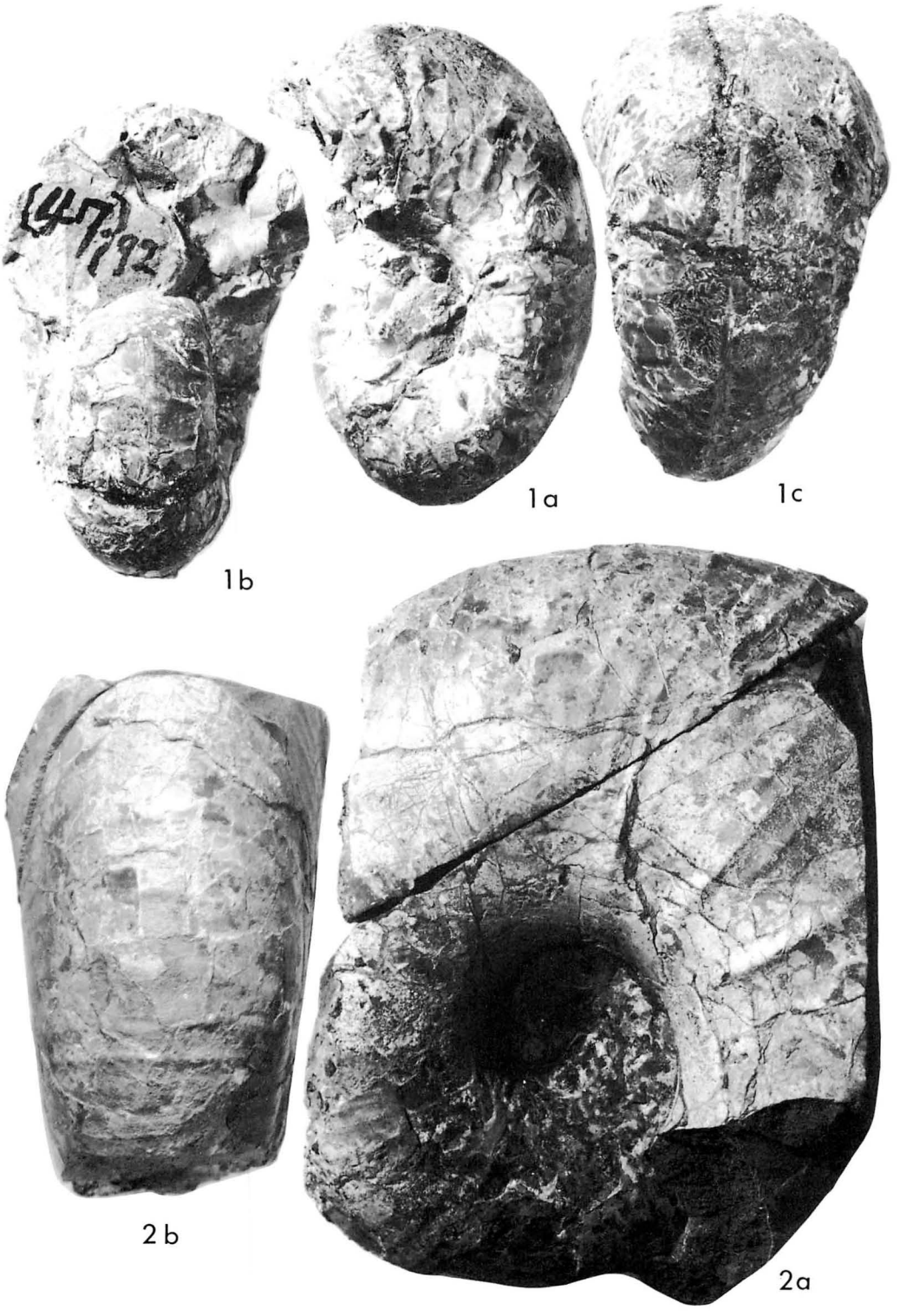
T. Matsumoto & T. Miyauchi: Soya Area

Plate 15

Explanation of Plate 15

Fig. 1. *Anapachydiscus* cf. *A. deccanensis* (Stoliczka) . . . . . Page 46
MNH. 190 from Soya harbour, T. Miyauchi Coll. Lateral (a), frontal (b) and ventral (c) views, x 1.

Fig. 2. *Pachydiscus sahekii* Matsumoto et Miyauchi, sp. nov. . . . . Page 43
Paratype, MNH. 189, from Soya harbour, T. Miyauchi Coll. Lateral (a) and ventral (b) views, x 0.9.



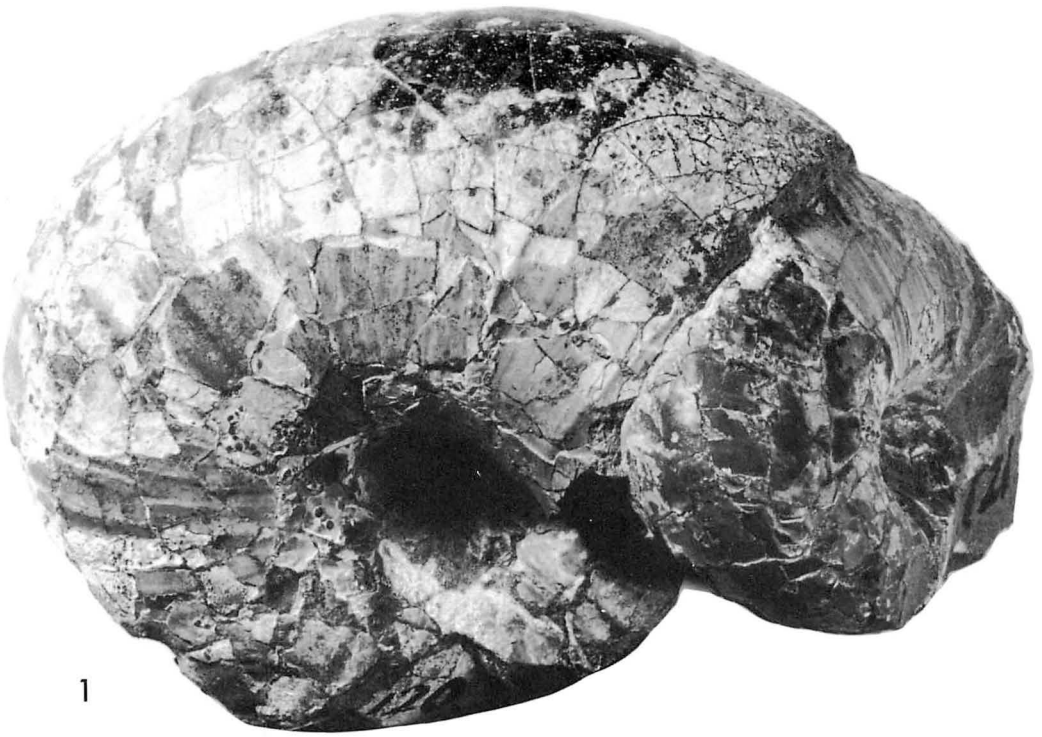
T. Matsumoto & T. Miyauchi: Soya Area

Plate 16

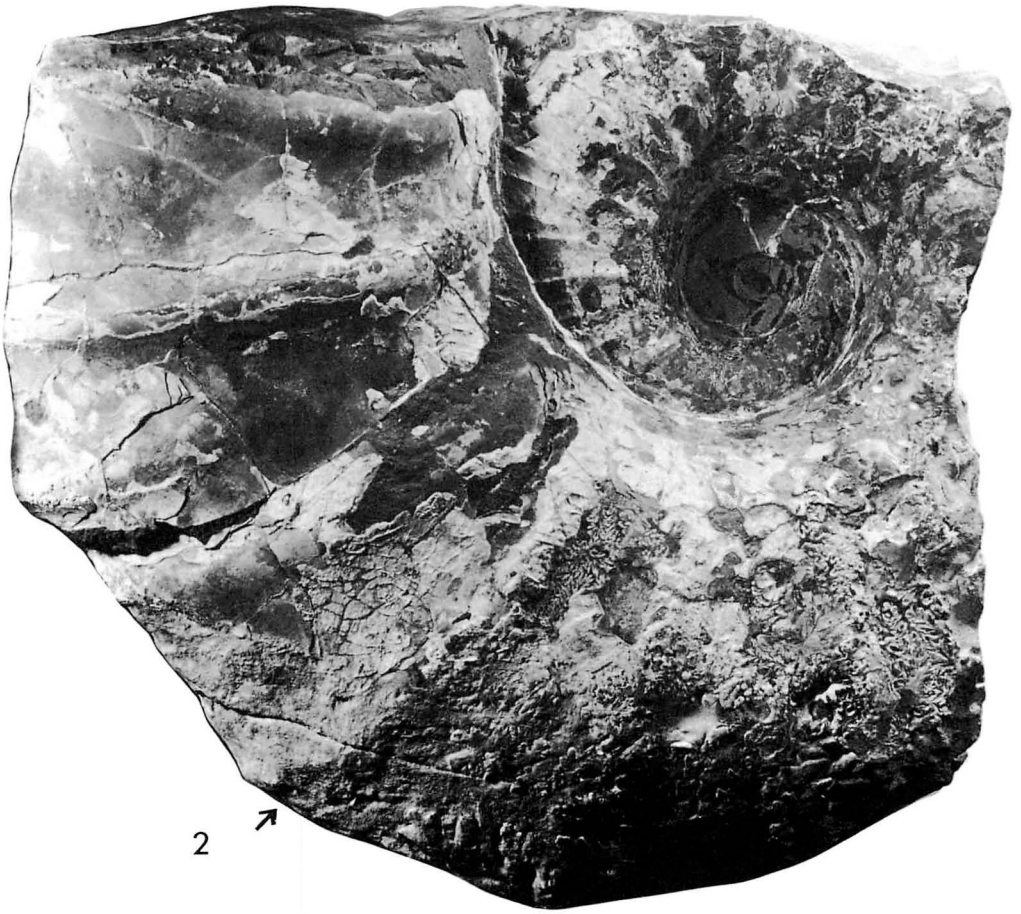
Explanation of Plate 16

Fig. 1. *Pachydiscus soyaensis* Matsumoto et Miyauchi, sp. nov. (MNH. 120, lateral view, x 1) and *Pseudomenuites* sp. (MNH. 120, oblique back view) attached together. T. Miyauchi Coll. from Soya harbour . . . . . Page 41, Page 47

Fig. 2. *Pachydiscus sahekii* Matsumoto et Miyauchi, sp. nov. . . . . Page 43
Paratype, MNH. 188, from south of Soya harbour, T. Masuda Coll. Lateral view, x 0.5. → Last suture.



1



2

T. Matsumoto & T. Miyauchi: Soya Area

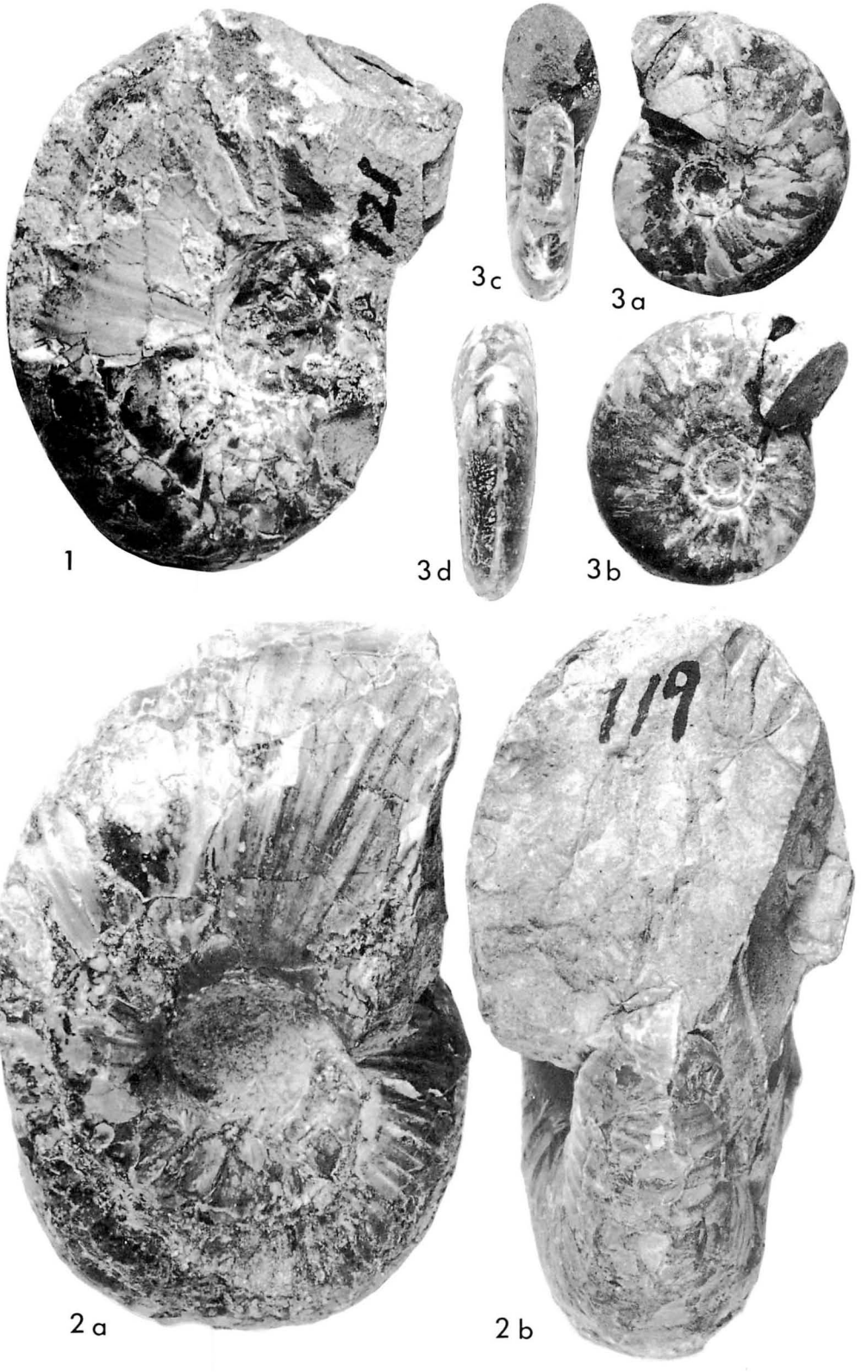
Plate 17

Explanation of Plate 17

Fig. 1. *Pseudomenuites* sp. . . . . Page 47
MNH. 121 from Soya harbour, T. Miyauchi Coll. Lateral view, x 1.

Fig. 2. *Pachydiscus soyaensis* Matsumoto et Miyauchi, sp. nov. . . . . Page 41
Paratype, MNH. 119, from Soya harbour, T. Miyauchi Coll. Lateral (a) and frontal (b) views, x 1.

Fig. 3. *Zelandites kawanoi* (Jimbo) . . . . . Page 58
MNH. 153 from Kiyohama-II, T. Miyauchi Coll. Two lateral (a, b), frontal (c) and ventral (d) views, x 1.



T. Matsumoto & T. Miyauchi: Soya Area

Plate 18

Explanation of Plate 18

Figs. 1, 2. *Canadoceras multicostatum* Matsumoto . . . . . Page 47

1. MNH. 206 from Soya harbour, T. Miyauchi Coll. Lateral view of a nearly smooth outer whorl with weak ribs remaining on the posterior part, x about 1/3.
2. MNH. 207 from Soya harbour, T. Miyauchi Coll. Lateral (a) and ventral (b) views of the next inner whorl, x 0.5.

T. Matsumoto & T. Miyauchi: Soya Area

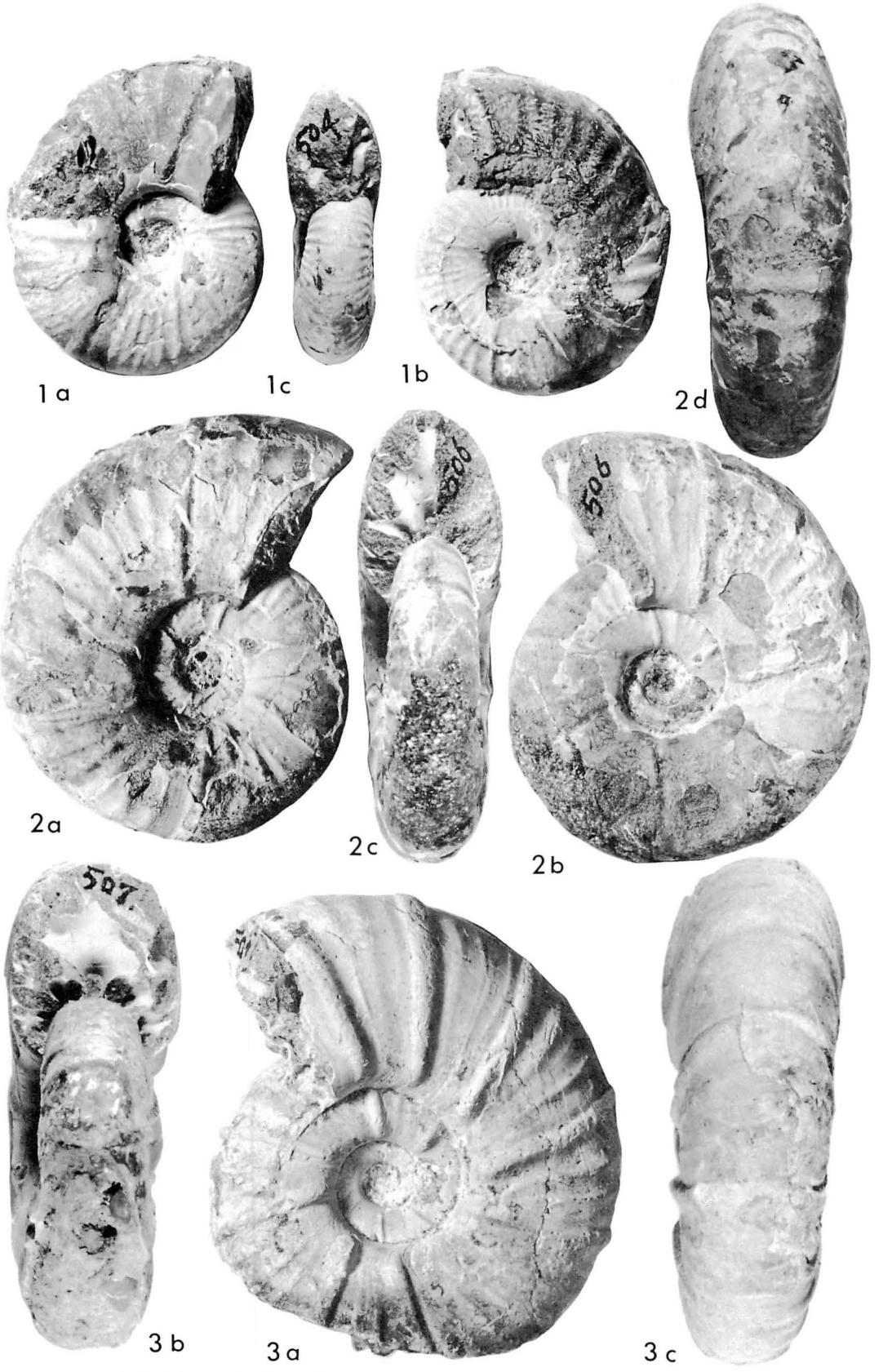
Plate 19

Explanation of Plate 19

Fig. 1. *Canadoceras minimum* Matsumoto et Miyauchi, sp. nov. . . . . Page 50
Paratype, GK. H5977 (=MNH. 504), from Kiyohama-I, T. Miyauchi Coll. Two lateral (a, b) (× 5/4) and frontal (c) (× 1) views.

Figs. 2, 3. *Canadoceras mysticum* Matsumoto . . . . . Page 48

2. MNH. 506 from Kiyohama-I, T. Miyauchi Coll. Two lateral (a, b), frontal (c) and ventral (d) views, × 1.
3. MNH. 507 from Kiyohama-I, T. Miyauchi Coll. Right lateral (a), frontal (b) and ventral (c) views, × 1. See also Pl. 20, Fig. 3 for another view.



T. Matsumoto & T. Miyauchi: Soya Area

Plate 20

Explanation of Plate 20

Fig. 1. *Canadoceras minimum* Matsumoto et Miyauchi, sp. nov. . . . . Page 50
Holotype, GK. H5976 (=MNH. 508), from Kiyohama-I, T. Miyauchi Coll. Two lateral (a, b) and ventral (c) views, x 2.

Fig. 2. *Canadoceras multicostatum* Matsumoto . . . . . Page 47
MNH. 505 from Kiyohama-I, T. Miyauchi Coll. Two lateral (a, b), ventral (c) and frontal (d) views, x 1.

Fig. 3. *Canadoceras mysticum* Matsumoto . . . . . Page 48
MNH. 507 from Kiyohama-I, T. Miyauchi Coll. Left lateral view, x 1. See also Pl. 19, Fig. 3a–c for other views.

1a

1c

1b

2a

3

2c

2b

2d

T. Matsumoto & T. Miyauchi: Soya Area

Plate 21

Explanation of Plate 21

Figs. 1–2. *Canadoceras minimum* Matsumoto et Miyauchi, sp. nov. . . . . Page 50

1. Paratype, MNH. 143, from Kiyohama-I, T. Miyauchi Coll. Two lateral (a, b), ventral (c) and frontal (d) views, x 1.5.
2. Paratype, MNH. 142, from Kiyohama-I, T. Miyauchi Coll. Left lateral (a) (x 1.5), right lateral (b) and ventral (c) views, x 1.2.

Fig. 3. *Pachydiscus soyaensis* Matsumoto et Miyauchi, sp. nov. . . . . Page 41

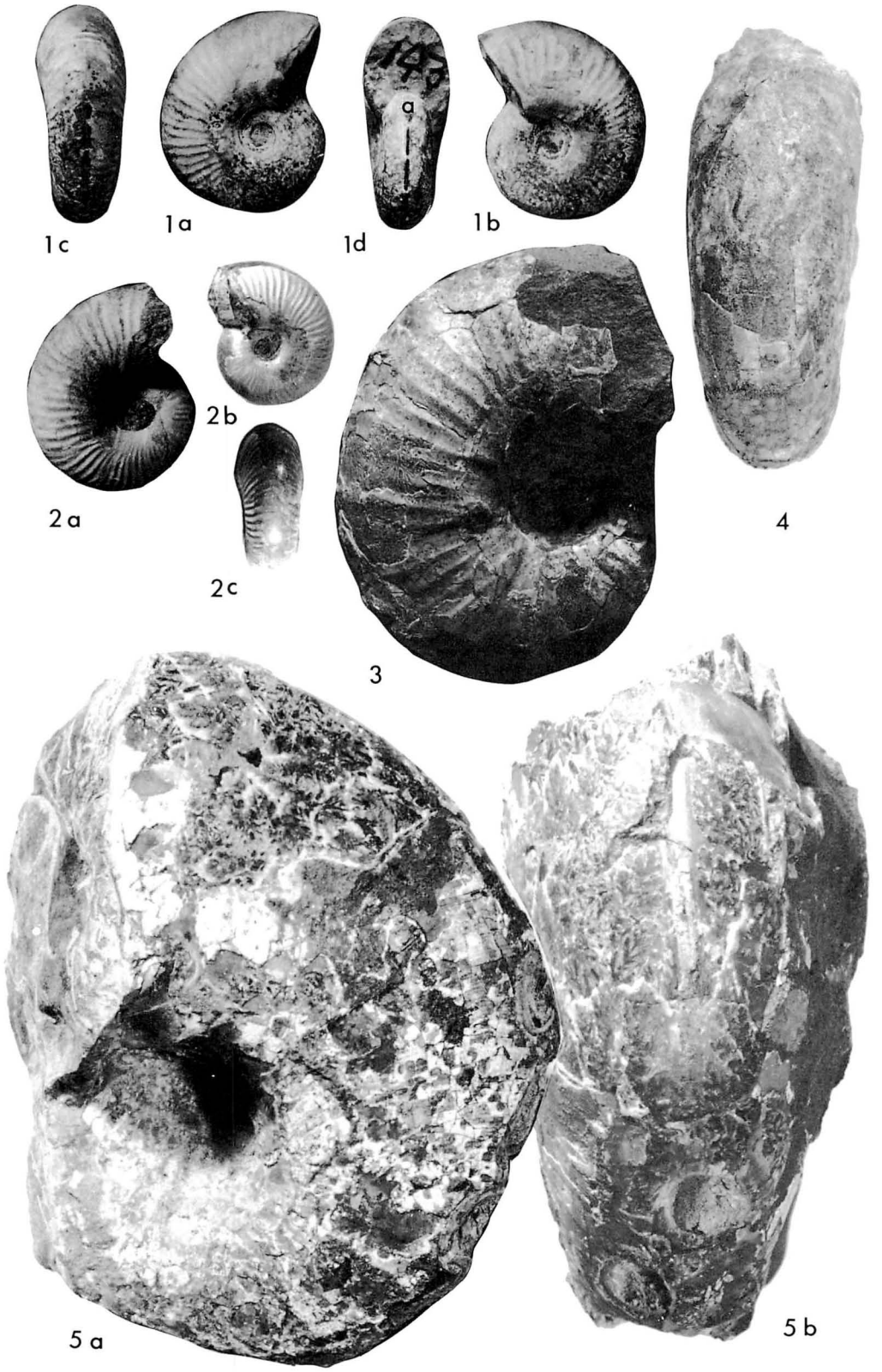
Paratype, MNH. 204, from Soya harbour, H. Honma Coll. Lateral view, x 1.

Fig. 4. *Pseudophyllites* cf. *P. teres* (van Hoepen) . . . . . Page 54

MNH. 208 from Soya harbour, T. Miyauchi Coll. Ventral view, x 1. See Pl. 23, Fig. 5 for lateral view.

Fig. 5. *Pseudophyllites indra* (Forbes) . . . . . Page 54

MNH. 231 from Soya harbour, T. Miyauchi Coll. Lateral (a) and ventral (b) views, x 1.



T. Matsumoto & T. Miyauchi: Soya Area

Plate 22

Explanation of Plate 22

Figs. 1–2. *Metaplacenticeras subtilistriatum* (Jimbo) . . . . . Page 51

1. MNH. 196 from Kiyohama-II (W7D), T. Miyauchi Coll. Two lateral (a, b) and ventral (c) views, x 1.
2. MNH. 201 from Kiyohama-II (W7D), T. Miyauchi Coll. Lateral view of a specimen embedded in sandstone, x 1.

Fig. 3. *Anapachydiscus* cf. *A. fascicostatus* (Yabe) . . . . . Page 45

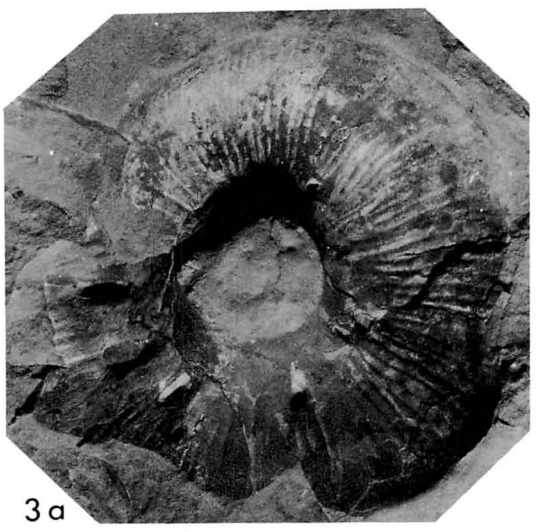
MNH. 195A from south of Soya, T. Miyauchi Coll. Lateral view of a large external mould on sandstone (a), x about 1/3. MNH. 195B, part of outer whorl (internal mould) (b) x 1/2 (M. Noda & S. Toshimitsu photo). Scale bar for 3b = 20 mm.

1a

1b

1c

2



3a

3b

Plate 23

Explanation of Plate 23

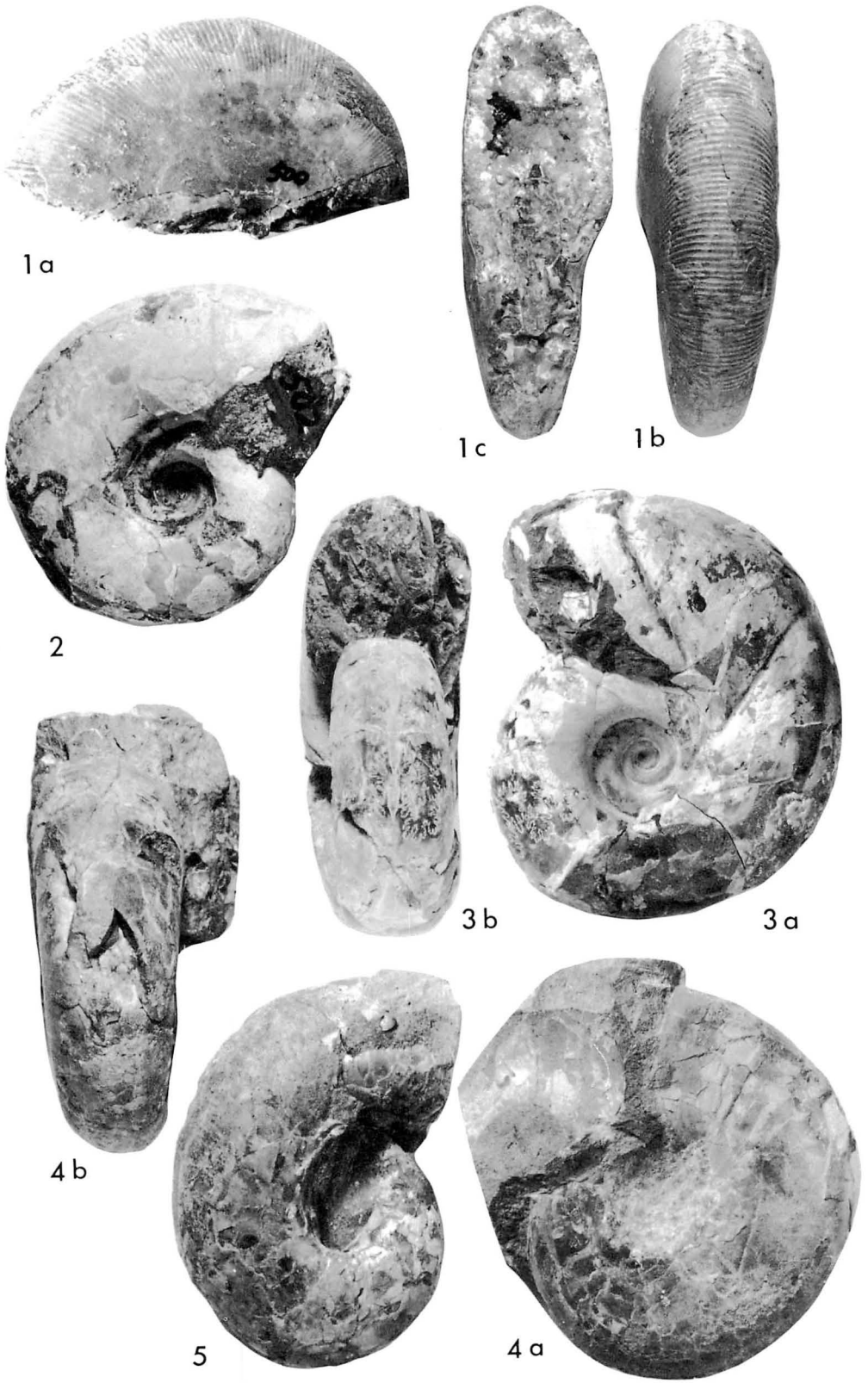
Fig. 1. *Neophylloceras* sp. nov. aff. *N. ramosum* (Meek) . . . . . Page 37
MNH. 500 from Kiyohama-I, T. Miyauchi Coll. Lateral (a) and ventral (b) views; cross-section (c), x 1.

Fig. 2. *Tetragonites superstes* van Hoepen . . . . . Page 52
MNH. 502 from Kiyohama-I, T. Miyauchi Coll. Lateral view, x 1.3.

Fig. 3. *Tetragonites popetensis* Yabe . . . . . Page 52
MNH. 501 from Kiyohama-I, T. Miyauchi Coll. Lateral (a) and frontal (b) views, x 1.

Figs. 4–5. *Pseudophyllites* cf. *P. teres* (van Hoepen) . . . . . Page 54

4. MNH. 207 from Kiyohama-I, T. Miyauchi Coll. Lateral (a) and ventral (b) views, x 1.
5. MNH. 208 from Kiyohama-I, T. Miyauchi Coll. Lateral view, x 1. See also Pl. 21, Fig. 4 for ventral view.

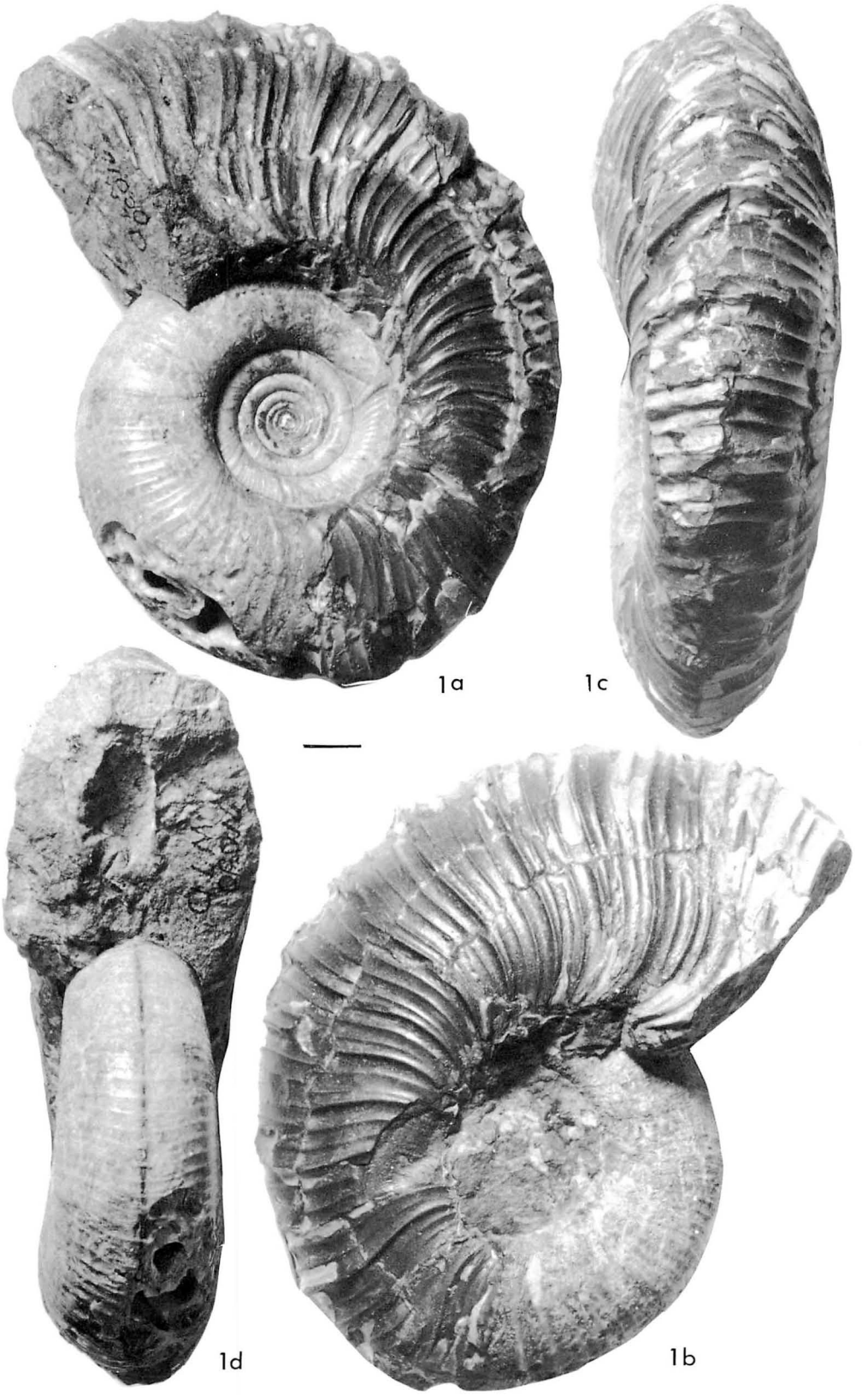


T. Matsumoto & T. Miyauchi: Soya Area

Plate 24

Explanation of Plate 24

Fig. 1. *Gaudryceras mamiyai* Matsumoto et Miyauchi, sp. nov. . . . . Page 55
Holotype, GK. H5974 (=MNH. 71030), from Kiyohama-II, T. Miyauchi Coll. Two lateral (a, b), ventral (c) and frontal (d) views, x 0.9. Scale bar = 10 mm.



T. Matsumoto & T. Miyauchi: Soya Area

Plate 25

Explanation of Plate 25

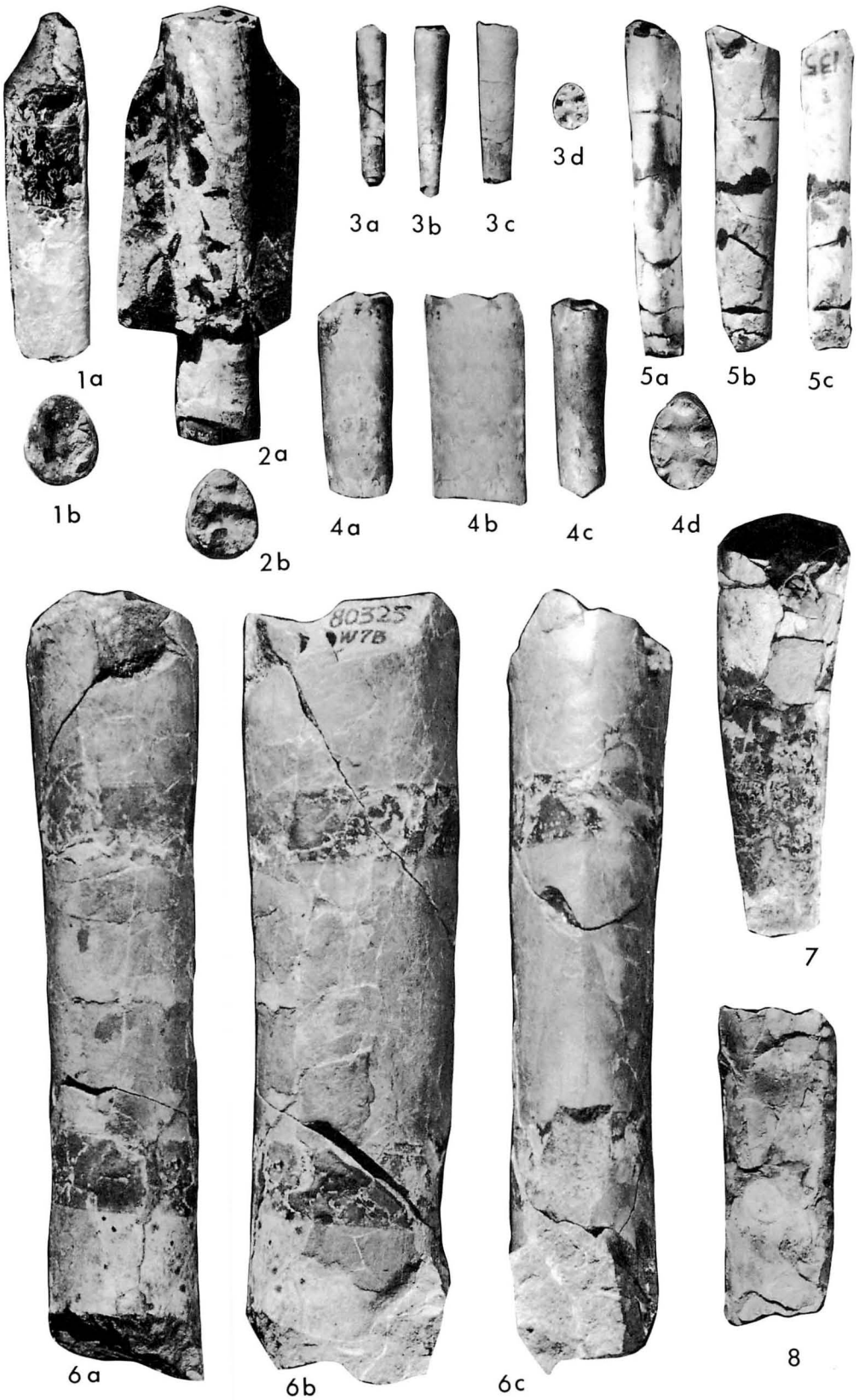
Figs. 1–5. *Baculites chicoensis yezoensis* Matsumoto et Miyauchi, subsp. nov. . . . . Page 70

1. Holotype, GK. H5975 (=MNH. 141), from Kiyohama-II, T. Miyauchi Coll. Lateral view (a) and cross-section (b), x 1.
2. Paratype, MNH. 137, from Kiyohama-II, T. Miyauchi Coll. Lateral view (a)and cross-section (b), x 1.
3. Paratype, MNH. 134, from Kiyohama-II, T. Miyauchi Coll. Ventral (a), dorsal (b) and lateral (c) views and cross-section (d), x 1.
4. Paratype, MNH. 133, from Kiyohama-II, T. Miyauchi Coll. Dorsal (a), lateral (b) and ventral (c) views; cross-section (d), x 1.2.
5. Paratype, MNH. 135, from Kiyohama-II, T. Miyauchi Coll. Ventral (a), lateral (b) and dorsal (c) views, x 1.

Fig. 6. *Baculites inornatus* Meek . . . . . Page 72
MNH. 132 (=80325) from Soya harbour, T. Miyauchi Coll. Dorsal (a), lateral (b) and ventral (c) views, x 1.

Fig. 7. *Baculites kotanii* Matsumoto, Hashimoto et Furuichi . . . . . Page 73
MNH. 130 from Soya harbour, T. Miyauchi Coll. Lateral view, x 1.

Fig. 8. *Baculites* sp. aff. *B. menabensis* Collignon . . . . . Page 74
MNH. 139 from Kiyohama-II, T. Miyauchi Coll. Lateral view, x 1.

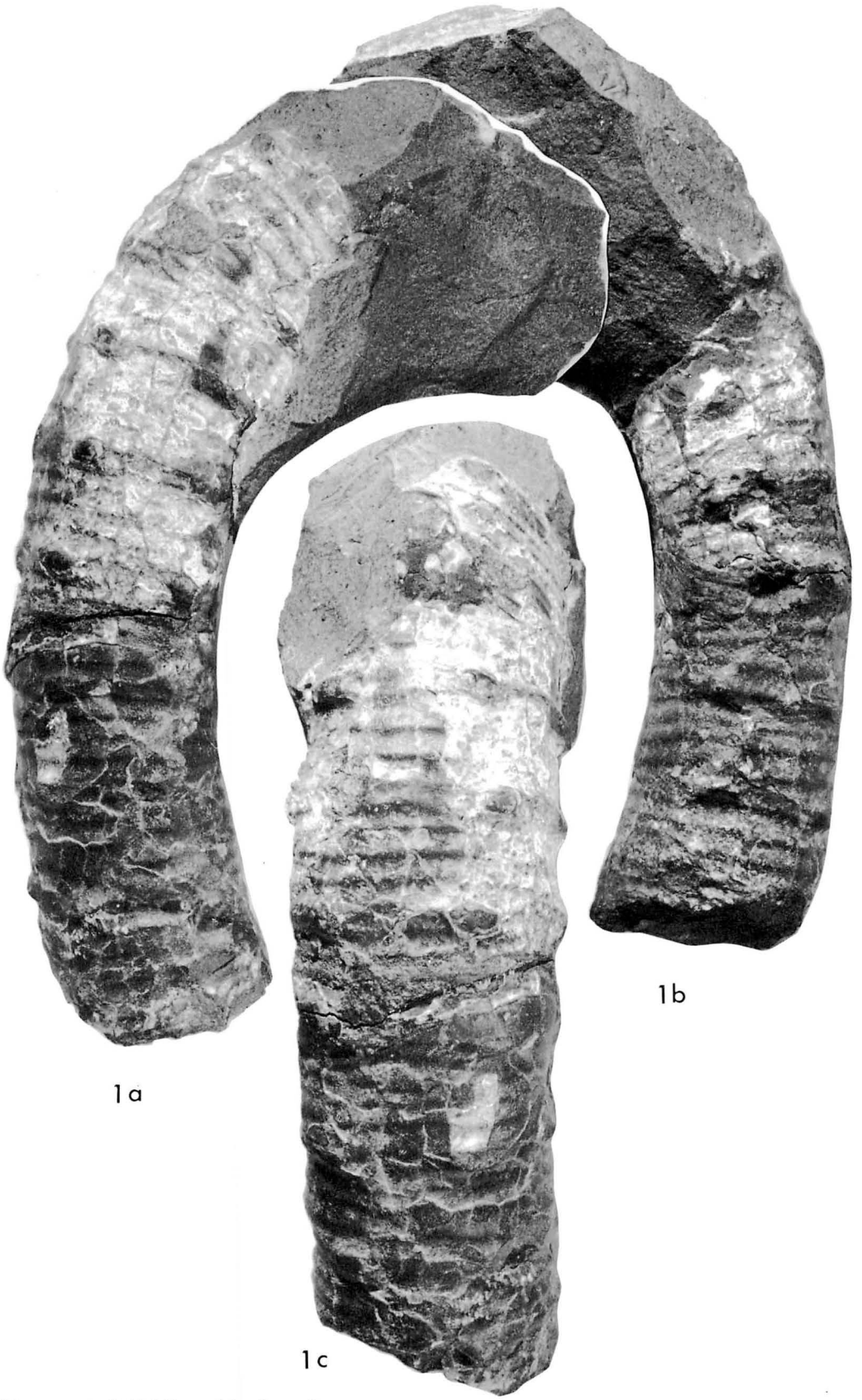


T. Matsumoto & T. Miyauchi: Soya Area

Plate 26

Explanation of Plate 26

Fig. 1. *Schlueterella kawadai* Matsumoto et Miyauchi, sp. nov. . . . . Page 61
Holotype, GK. H5978 (=MNH. 81), from Soya harbour, T. Miyauchi Coll. Two lateral (a, b) and ventral (c) views, x 1.



T. Matsumoto & T. Miyauchi: Soya Area

Plate 27

Explanation of Plate 27

Fig. 1. *Ryugasella ryugasensis* Wright et Matsumoto . . . . . Page 67
MNH. 201 from Ohmisaki (W4C), T. Miyauchi Coll. Dorsal (a), ventral (b) and lateral (c) views, x 1.

Fig. 2. *Diplomoceras notabile* Whiteaves . . . . . Page 68
MNH. 214 from Soya harbour, T. Miyauchi Coll. Lateral view of a juvenile example, x 2.

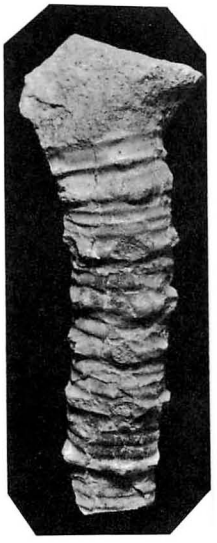
Figs. 3–4. *Schlueterella kawadai* Matsumoto et Miyauchi, sp. nov. . . . . Page 61

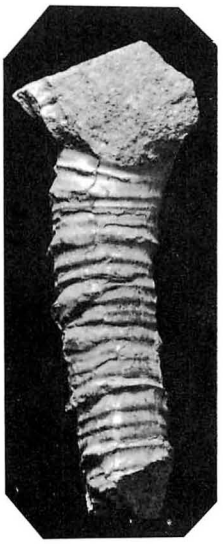
3. Paratype, MNH. 215 from Soya harbour, T. Saheki Coll. Fragmentary immature specimen (a) embedded in sandstone, showing spines; ventral (b), dorsal (c) and two lateral (d, e) views of the same specimen, x 1.
4. Holotype, GK. H5978 (=MNH. 81), from Soya harbour, T. Miyauchi Coll. Dorsal view, x 1. See Pl. 26 for other views.


1a 1b 1c


2


3a


3b


3c


3d


3e


4

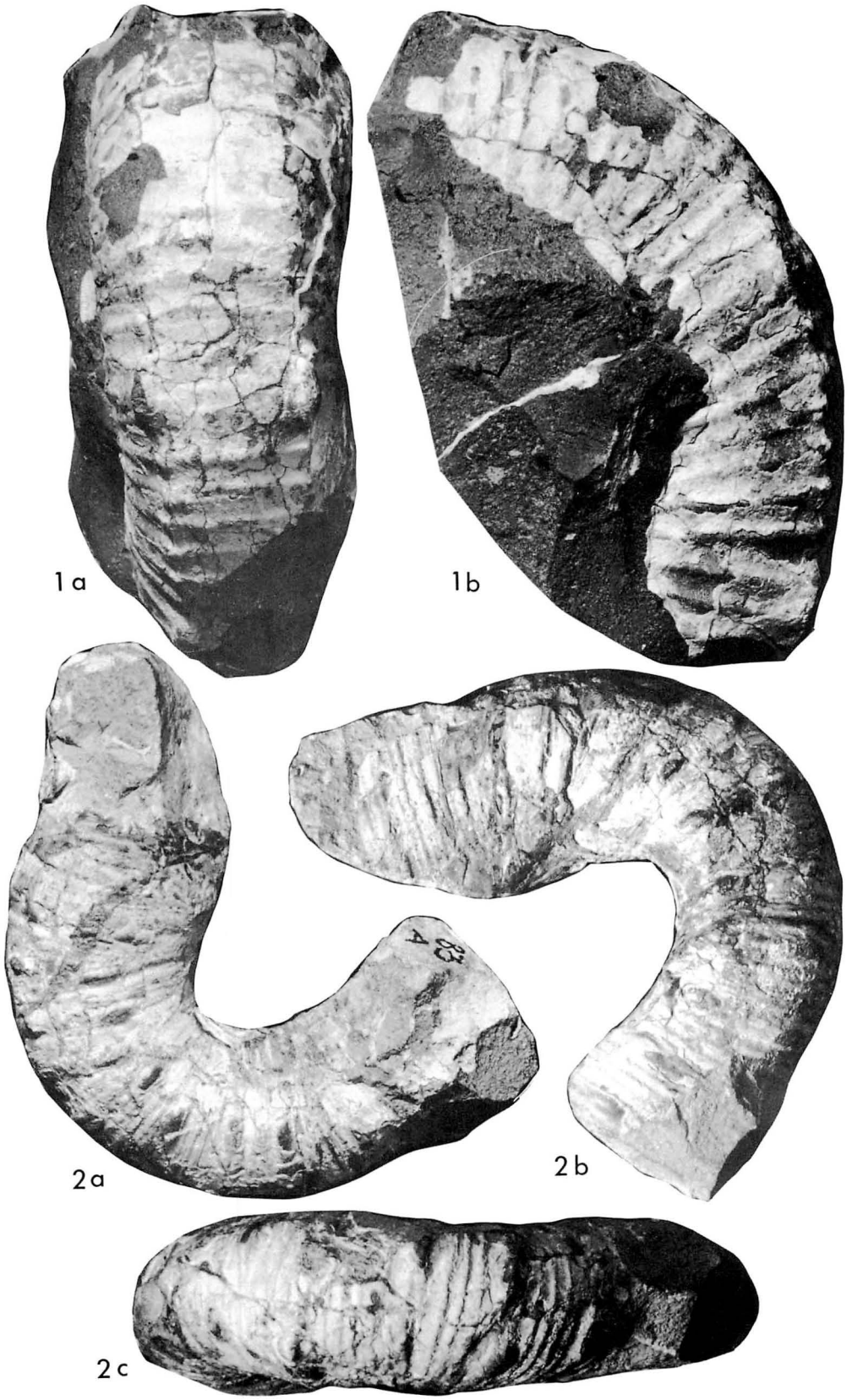
T. Matsumoto & T. Miyauchi: Soya Area

Plate 28

Explanation of Plate 28

Fig. 1. *Parasolenoceras periodicum* Matsumoto et Miyauchi, sp. nov. . . . . Page 64
Paratype, MNH. 220, from Soya harbour, T. Miyauchi Coll. Ventral (a) and lateral (b) views, about x 1 (slightly reduced).

Fig. 2. *Schlueterella kawadai* Matsumoto et Miyauchi, sp. nov. . . . . Page 61
Paratype, MNH. 83A, from Soya harbour, T. Miyauchi Coll. Two lateral (a, b) and ventral (c) views, x 1.

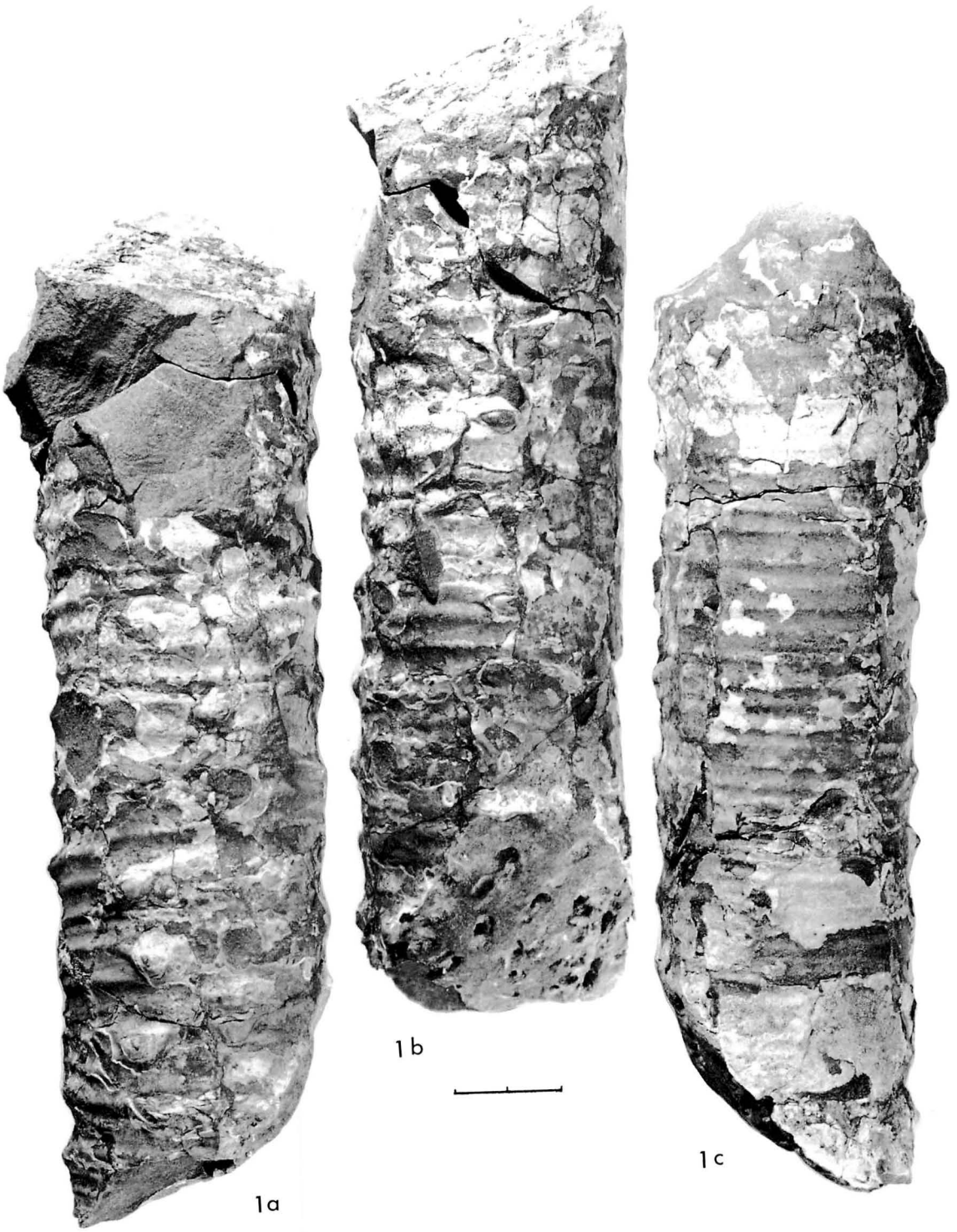


T. Matsumoto & T. Miyauchi: Soya Area

Plate 29

Explanation of Plate 29

Fig. 1. *Schlueterella kawadai* Matsumoto et Miyauchi, sp. nov. . . . . Page 61
Paratype, MNH. 212, from Soya harbour, T. Miyauchi Coll. Ventral (a), lateral (b) and dorsal (c) views, about x 0.8. Scale bar = 20 mm.



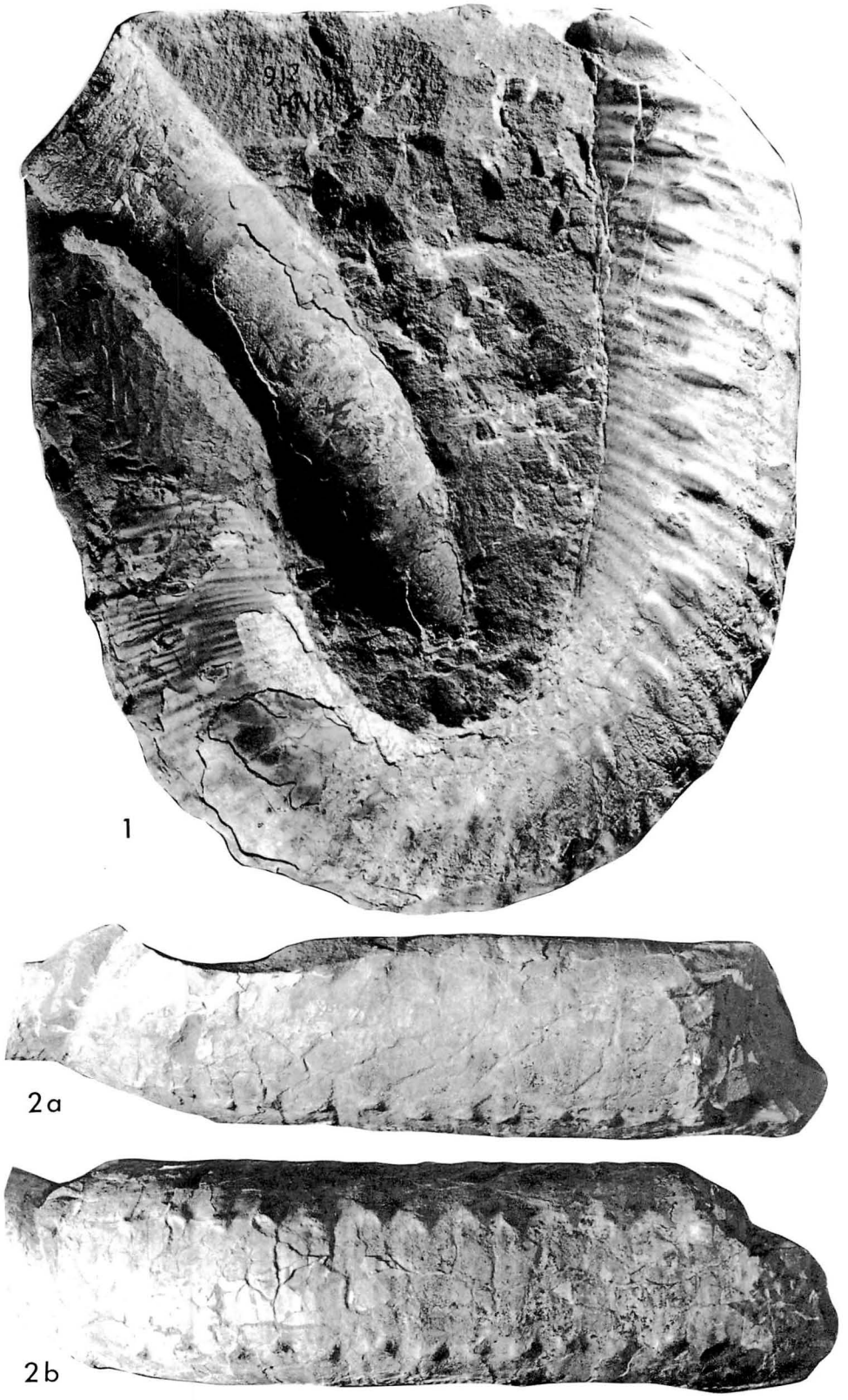
T. Matsumoto & T. Miyauchi: Soya Area

Plate 30

Explanation of Plate 30

Figs. 1–2. *Schlueterella kawadai* Matsumoto et Miyauchi, sp. nov. . . . . Page 61

1. Paratype, MNH. 216, from Soya harbour, T. Saheki Coll. Lateral view of the hooked part of a large body-chamber, x 1/3.
2. Paratype, MNH. 111, from Soya harbour, T. Miyauchi Coll. Lateral (a) and ventral (b) views, x about 1/3.



T. Matsumoto & T. Miyauchi: Soya Area

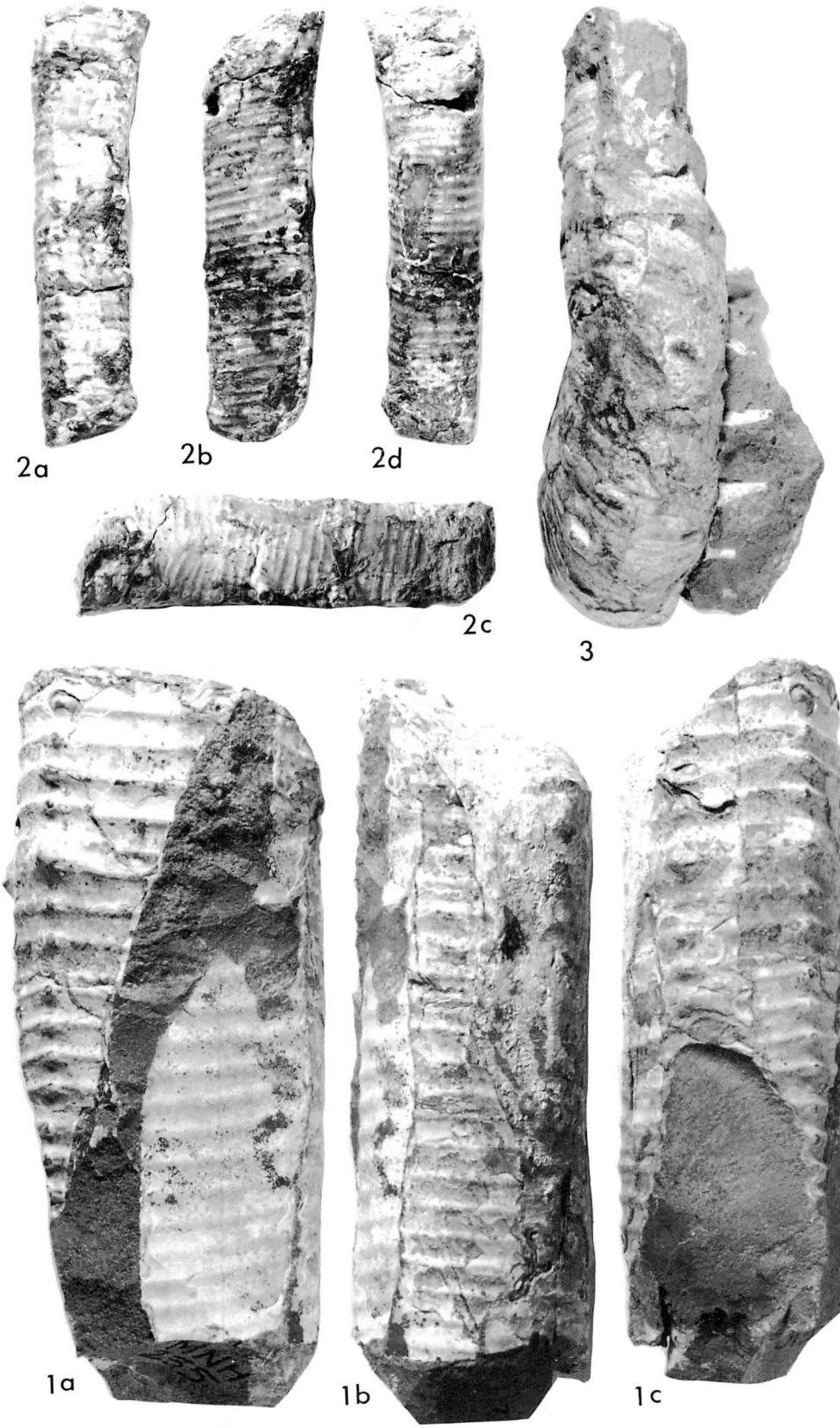
Plate 31

Explanation of Plate 31

Fig. 1. *Parasolenoceras periodicum* Matsumoto et Miyauchi, sp. nov. . . . . Page 64
Holotype, GK. H5979 [=MNH. 235] from Soya harbour. Lateral (a), dorsal (b) and ventral (c) views, x 1.

Fig. 2. *Parasolenoceras* sp. cf. *P. periodicum* Matsumoto et Miyauchi, sp. nov. . . . . Page 65
MNH. 129 from Kiyohama-I. Ventral (a), two lateral (b, c) and dorsal (d) views, x 1.

Fig. 3. *Schlueterella kawadai* Matsumoto et Miyauchi, sp. nov. . . . . Page 61
Paratype MNH. 83A, B from Soya harbour. Ventral views of a curved part with spines, x 1. (See Pl. 28, Fig. 2 for other views.)



T. Matsumoto & T. Miyauchi: Soya Area

PART III. CONCLUDING REMARKS

– Summary of Results and Discussions –

By

T. MATSUMOTO

(1) *Taxonomic Result:*–The ammonite species which occur in the beds with *Metaplacenticeras subtilistriatum* and in the immediately underlying beds are listed in Table 1. They are altogether 41, of which 37 are described in this paper. The species newly established on the material from the studied areas are eleven (marked with *), of which one (*Hoplitoplacenticeras monju*) has already been introduced in my shorter paper (Matsumoto, 1982a) for its special importance. In addition to the eleven species there are a new subspecies and two probably new but unnamed species. Other two thirds of the fauna are referred to the known species, some of which have been revised to a considerable extent. Certain genera, e.g. *Neophylloceras, Phyllopachyceras, Anapachydiscus, Metaplacenticeras, Hoplitoplacenticeras, Polyptychoceras, Diplomoceras, Ryugasella, Schlueterella* and *Parasolenoceras,* have been redefined with necessary discussion.

In addition to the 37 species there are several which are not described in this paper but listed in Table 1. *Gaudryceras striatum* (Jimbo), *G. crassicostatum* (Jimbo) and *Gaudryceras* sp. nov.(?) need systematic descriptions on another occasion together with other related species. On the other hand, *Canadoceras kossmati* Matsumoto is well defined and omitted from the redescription. There are a few heteromorph ammonites which are too fragmentary for the full description. By further careful search, some more species may be found from the formations concerned. These should be reported in a supplementary paper rather than to delay the publication of this monograph.

(2) *The Zone of Metaplacenticeras subtilistriatum:*–A zone in the biostratigraphy can be defined in various ways (Hedberg, 1976; Holland *et al.*, 1978). I myself once discussed, with I. Otaba, about the nature of the ammonite zones which are actually dealt with in our biostratigraphic studies (Matsumoto & Obata, 1979). That paper was written in Japanese but its essential points were orally communicated on the occasion of the symposium on the Ammonoidea at York, 1979. To quote from that communication: "I generally follow Oppel and Arkell to recognize a zone in a field work and extend it for a correlation. Various kinds of zones as defined by Hedberg may be principally acceptable but are hardly confirmed in the basic field work of ammonite biostratigraphy. Lineage zones may be the most reasonable for a chronological subdivision and correlation, but they are usually recognized in a specially closed province and hardly extended for the inter-regional correlation. Oppel's Zone is practically more useful than the principally defined ones such as lineage- and range-zones. It comprises, however, products of evolutionary diversities in ammonite phylogeny and are affected much by the environmental and also sedimentologic factors, which have given the most favourable condition

for a (or several) particular species to occur characteristically in a given zone. Therefore, careful consideration should be taken for a zonal correlation."

Now in the case of the Campanian of the Teshio Mountains and the Soya area, the actual state of what would be called the Zone of *Metaplacenticeras subtilistriatum* is as follows.

Table 1. List of ammonite species from the studied areas of Teshio and Soya

	Teshio		Soya				Occur. beyond NW. Pacific
	W	Y	F	H	I	J	
Neophylloceras ramosum (Meek)		+	+				×
▼ *Neophylloceras* aff. N. *ramosum* (Meek)(*)			+				
Neophylloceras cf. *N. nera* (Forbes)		+	+				×
Neophylloceras hetonaiense Matsumoto		+	+				×
Phyllopachyceras ezoense (Yokoyama)		×	+	×			× ?
Desmophyllites diphylloides (Forbes)		+	●	●	+	+	×
Mesopuzosia densicostata Matsumoto		+					
Anapachydiscus fascicostatus (Yabe)		●				+	
Anapachydiscus cf. *A. deccanensis* (Stoliczka)				+			×
Menuites sanadai Matsumoto*		+					
Pachydiscus soyaensis Matsumoto & Miyauchi*				●			
Pachydiscus sahekii Matsumoto & Miyauchi*				+			
Pseudomenuites sp. (*)				+			
▼ *Canadoceras kossmati* Matsumoto			×				
Canadoceras mutlticostatum Matsumoto		+	+	●		+	
Canadoceras mysticum Matsumoto			●				×
Canadoceras minimum Matsumoto & Miyauchi*			+				
Metaplacenticeras subtilistriatum (Jimbo)		●		+	●	+	
Hoplitoplacenticeras monju Matsumoto*		+					
Hoplitoplacenticeras fugen Matsumoto*		+			×		
▼ *Tetragonites superstes* van Hoepen			+				×
Tetragonites popetensis Yabe			+	×			×
Saghalinites teshioensis Matsumoto*		+					
Pseudophyllites indra (Forbes)				+			×
Pseudophyllites cf. *P. teres* (van Hoepen)				+			×
Gaudryceras striatum (Jimbo)		×	×	×	×		×
Gaudryceras crassicostatum (Jimbo)				×			
Gaudryceras mamiyai Matsumoto & Miyauchi*				+			
Gaudryceras sp.(*)				×			
Zelandites kawanoi (Jimbo)			×	+			
Polyptychoceras pseudogaultinum (Yokoyama)		+					
Diplomoceras notabile Whiteaves		+		+			×
▼ *Ryugasella ryugasensis* Wright & Matsumoto							×
Schlueterella kawadai Matsumoto & Miyauchi*	+			●			×
Parasolenoceras tomitai Matsumoto*		+					
Parasolenoceras periodicum Matsumoto & Miyauchi*				×			
Baculites inornatus Meek				●			×
▼ *Baculites chicoensis yezoensis* Matsumoto & Miyauchi*			●				×
Baculites kotanii Matsumoto *et al.*					+		
▼ *Baculites* aff. *B. menabensis* Collignon			+				×
Baculites subanceps pacificus Matsumoto & Obata		×		+			×

* new species or subspecies established from the studied material, ▼ species not found in the Upper Campanian but described or mentioned in this paper, ● abundant or common, + present but not so common, × present but not indicated under the material of palaeontologic description; W, Y: Members W and Y in the sequences of the Teshio Mountains, F, H, I, J: Members F, H, I and J in the sequences of the Soya area.

In the Teshio Mountains, the particular member (dark coloured silty sandstone) in the middle of the Yasukawa Group, is rich in *M. subtilistriatum*. This is represented by 55 m sequence of the main part of Member Y in the type section of the Wembets-Rubeshbe and its extensions. In addition to this species there are 18 ammonite species (see Table 1), of which *Anapachydiscus fascicostatus, Menuites sanadai, Hoplitoplacenticeras monju, H. fugen* and *Saghalinites teshioensis* may be the important associates with the index species. In contrast to this prolific part, the medium to coarse-graind corss-bedded sandstone of the underlying Member X and the overlying Member Z are poor in fossils, except for fragmentary wood. Therefore, the prolific part, well recognized in our field work, is naturally called the Zone of *M. subtilistriatum*. It is, however, difficult to know the true vertical range of this species, because the sediments of Members X and Z must have been formed under unfavourable conditions for the preservation of ammonites. Only a single specimen of *Schlueterella kawadai* has been found from the upper part of still underlying Member W.

In the Soya area, *M. subtilistriatum* does not occur so abundantly as in the above mentioned case, but occurs characteristically in Member I of dark coloured silty sandstone, which is similar in lithology but not quite identical with Member Y of the Teshio Mountains. In this member calcareous nodules are rare and ammonites are embedded directly in the muddy sandstone. Therefore they are not so well preserved as those in Member Y of Teshio. The associated ammonites are also poor, but *Hoplitoplacenticeras* cf. *H. fugen* does occur. Therefore, despite the scattered occurrence, Member I has been called the Zone of *M. subtilistriatum* in our filed work and at least tentatively correlated with Member Y of Teshio.

In the case of Soya, however, Member H, which underlies Member I, is fairly fossiliferous, containing 21 species of ammonites. This is a high contrast to the situation in Teshio. The most diagnostic species among the 21 is *Schlueterella kawadai*, which is often associated with *Pachydiscus soyaensis, Canadoceras multicostatum, Diplomoceras notabile* and *Baculites inornatus*. Fewer but noteworthy associates are *M. subtilistriatum, B.* cf. *subanceps pacificus, Pachydiscus sahekii* and *Gaudryceras mamiyai*, of which the last two are entirely new. Member J, which overlies Member I, has intercalated beds of less muddy, compact sandstone, but is somewhat fossiliferous. The identified ammonites from it are *Desmophyllites diphylloides, Anapachydiscus fascicostatus, Canadoceras multicostatum* and again *M. subtilistriatum*.

Thus, in the Soya area, the Zone of *M. subtilistriatum* can be defined in a broader sense to include the whole fossiliferous sequences of Members H, I and J.

It is noted that *M. subtilistriatum* occurs in dissimilar way between the Teshio and the Soya areas, which are separated for about 70 km. The assemblage of the ammonite species in the prolific part of the Zone of *M. subtilistriatum* is well shown in the Teshio Mountains, whereas that in the lower part of the Zone below the prolific part is well shown in the Soya area. These two assemblages are considerably dissimilar, if we exclude the long-ranging common species. Therefore the lower part can be called the Subzone of *Schlueterella kawadai*.

It is furthermore noted that in the Soya area the lower part (i.e. the Subzone of *S. kawadai*, represented by Member H) of the Zone of *M. subtilistriatum* is underlain by the upper part of the Zone of *Sphenoceramus schmidti- Canadoceras kossmati*, although some thickness of strata (Member G), without short ranging index species, exists at the intervening part. This upper part of the *Schmidti* Zone, represented by Member F or Fukiyose Beds of Soya contains 15 or more ammonite species of which *Canadoceras mysticum* may be selected at least locally as a subzonal index.

In the Teshio Mountains the intervening sequences between the prolific part of Zone of *M. subtilistriatum* and that of the Zone of *Sphenoceramus schmidti* are occupied by the non- or poorly fossiliferous coarse-grained pebbly sandstone in the lower part of the Yasukawa Group and the less fossiliferous bioturbated sandstone in the uppermost part of the Osuushinai Formation.

To sum up, the Teshio and the Soya areas are complementary to make clear the Zone of *M. subtilistriatum* and the underlying part. Because of the unconformity at the base of the overlying Tertiary, the relation of this Zone with the succeeding one is not well shown in the two areas.

(3) *Intra-provincial Correlation:–Metaplacenticeras subtilistriatum* has been recorded from the Urakawa area of southern Hokkaido (Matsumoto, 1942–43; Kanie, 1982) besides the Teshio and the Soya areas of northern Hokkaido. There, it occurs in a siltstone bed at a narrow synclinal portion in the upper reaches of the small stream Tsukisap [Tsukisappu by some authors], which is certainly at some distance above the strata with *Sphenoceramus schmidti* or *Sphenoceramus orientalis*, with a member of less fossiliferous sandstone inbetween. The ammonite species which occur in the *Metaplacenticeras* bearing bed have not yet been fully described, but I have identified preliminarily *Baculites inornatus, Didymoceras* sp. nov. and *Gaudryceras crassicostatum* in the collections of Messrs. Y. Kawashita and M. Yamashita, with whom I visited the localities. This bed of Urakawa is certainly correlated with a portion of the Zone of *M. subtilistriatum* in northern Hokkaido, although what part of the Zone cannot be decided on the available evidence.

Judging from the mode of occurrence and the sedimentological features of the containing strata, the optimum environment for *M. subtilistriatum* seems to have been limited and its fossil remains were embedded in a comparatively near shore shallow sea sediments. Therefore the Zone of *M. subtilistriatum* is not recognized in the sediments of a somewhat off-shore facies such as those in the Tombetsu area of northern Hokkaido to the east of the Soya- Teshio range, although there should be strata which are of the same age as this zone (see Matsumoto *et al.*, 1980; Matsumoto *et al.*, 1981). Similarly it is not recognized in the more coarse-grained sediments of the lower part of the Hakobuchi Group in central Hokkaido, although there should be its synchronous equivalent above the bed with *Sphenoceramus schmidti* and below the lower part of the Upper Hakobuchi with *Inoceramus* (*Endocostea*) *shikotanensis* Nagao et Matsumoto and *Neodesmoceras japonicum* Matsumoto.

M. subtilistriatum has recently been collected fairly commonly by several naturalists and geologists in the Izumi Group of the Asan Mountains (Shikoku), Southwest Japan. I am preparing a paper to describe it, together with the coworkers. The Izumi Group, which extends for about 500 km from Matsuyama in the west to the Izumi Mountains in the east, is Campanian and Maastrichtian in age, but it becomes transgressively younger as we go eastward (Suyari, 1973; Matsumoto, 1980). The member of dark coloured siltstone or shale, with some sandstone, near the base is fairly fossiliferous, but it runs diachronously. Near Matsuyama in the west it contains an assemblage characterized by *Sphenoceramus schmidti- Gigantocapulus giganteus*. Being separated by discontinuous exposures, next comes the western part of the Asan Mountains where *M. subtilistriatum* occurs characteristically in the extension of the member (called the Nakato Shale). This can be called the Zone of *M. subtilistriatum* in Shikoku, but whether it is correlated with the broadly define Zone of *M. subtilistriatum* of north-

ern Hokkaido or with the prolific part of that zone or otherwise is not yet determined. We should study the associated species.

In the Nakato Shale of the central to eastern part of the Asan Mountains the *Metaplacenticeras* bearing zone is succeeded by a subzone with *Baculites* spp. in which *B. kotanii* Matsumoto, Furuichi and Hashimoto, 1980 is a peculiar element, and then comes a subzone with *Didymoceras* sp. nov. (probably identical with the species from Urakawa mentioned above). This is followed by a subzone with *Didymoceras awajiense* (Yabe) and then that with *Pravitoceras sigmoidale* Yabe (see Matsumoto *et al.*, 1981). These are best exposed at the eastern extremity of the Asan Mountains and in the western part of Awaji Island facing the Straits of Naruto, where *Inoceramus* (*Endocostea*) *shikotanensis*, an indicator of the Lower Maastrichtian, occurs in the overlying bed. Another subzone is recognized inbetween by Morozumi (*in lit.* May 1983). The above facts in Southwest Japan imply that there is a room without *M. subtilistriatum* in the uppermost part of the Campanian.

Schlueterella kawadai occurs in Unit Ray_3 and Rby of the Naibuchi [Naibu] area in South Sakhalin, which is above the prolific part (Ray_1) of *Sphenoceramus schmidti*. This conforms well with the succession in the Soya area. *S. kawadai* is recorded in other areas of Sakhalin and would be a guide species in the intra-provincial correlation, along with certain associated species.

(4) *Correlation with the subdivisions of the international scale:*—Nomenclaturally the Campanian stage is based on the sections described by Coquand (1856, 1857, 1858) on the hillside at La Grand Champagne in Charente (southwestern France). Pending the issue of the resolutions which would be adopted by the IUGS Subcommission on Cretaceous Stratigraphy, I have to go back to the dates of Arnaud (1877) and de Grossouvre (1894; 1895–1901) for the ammonite zonation of the Campanian in the so-called standard area of Europe. It is as follows, with revised names of zonal indices:

overlying: Zone of *Pachydiscus neubergicus* (Lower Maastrichtian)

(4) Zone of *Didymoceras polyplocum* ┐
(3) Zone of *Hoplitoplacenticeras marroti* ┘ Upper Campanian

(2) Zone of *Delawarella delawarensis* ┐
(1) Zone of *Diplacmoceras bidorsatum* ┘ Lower Campanian

underlying: Zone of *Placenticeras syrtale* (Upper Santonian)

It should be noted that this was not established on the basis of the succession actually observed in the sequence of the stratotype, but that it is a compiled scheme and that the indicated ammonites occur sparsely.

Based on Schlüter's (1871–1876) work in northwestern Germany, Redtenbacher's (1873) and Brinkmann's (1935) works in Austria (the East Alps) as well as Wiedmann's (1960) work in Spain, Wiedmann (1979) also followed the quadripartite zonation but called the first and the third zones by the names of more common scaphitid species and referred the second zone to the Middle Campanian. The scheme adopted by Wiedmann (1979) is as follows:

overlying: Zone of *Pachydiscus neubergicus* (Lower Maastrichtian)

(4) Zone of *Didymoceras polyplocum* ┐
(*T. spiniger* is also listed here.) ┤ Upper Campanian
(3) Zone of *Trachyscaphites spiniger* ┘

(2) Zone of *Delawarella delawarensis* — Middle Campanian

(1) Zone of *Scaphites hippocrepis* — Lower Campanian

underlying: *Placenticeras syrtale* (Upper Santonian)

Based on the Upper Cretaceous sequences in the valley of the Middle Vistula River, Poland, Blaszkiewicz (1980) has added the Zone of *Didymoceras donezianum* and then the Zone of *Nostoceras pozaryskii* in the uppermost part of the Campanian above the Zone of *Didymoceras polyplocum*.

In the Gulf Coast province of North America, Young (1963) proposed the following zonal scheme:

overlying: not indicated

(4) Zone of *Hoplitoplacenticeras marroti* — Upper Campanian

(3) Zone of *Delawarella sabinalensis*

(2) Zone of *Delawarella delawarensis* — Lower Campanian

(1) Zone of *Submortoniceras tequesquitense*

Young did not use the term Middle Campanian, although he made a zonal correlation with Madagascar.

In the Western Interior province of the United States, Cobban, sometimes with his co-workers, has established a fine scheme of zonation for the Upper Cretaceous. The Campanian is, however, subdivided mainly by numerous species of *Baculites* with a few intercalates of *Didymoceras* and *Exiteloceras* species. Important species for the inter-regional correlation are *Scaphites hippocrepis* I, II, III, which defines the three zones (better to say subzones) in the lowest part of the Campanian, and the three species of *Trachyscaphites, T. praespiniger, T. spiniger porchi* and *T. redberdensis* (see Cobban & Scott, 1964), which occur successively in the Upper Campanian.

In the Pacific Coast of North America, my indication of the succession of selected ammonites in the Upper Cretaceous of California (Matsumoto, 1960) was tentative. As to the Nanaimo Group of British Columbia (Canada) and adjacent areas, there are tentative proposals by Muller & Jeletzky (1970) and by Ward (1978a). The scheme of Ward, with my slight modification, can be expressed as follows:

overlying: Zone of *Pachydiscus suciaensis* (lowest Maastrichtian to uppermost Campanian), with a barren zone below.

(4) Zone of *Metaplacenticeras pacificum*

(3) Zone of *Hoplitoplacenticeras vancouverensis* — Upper Campanian

(2) Zone of *Baculites chicoensis*

(1) Zone of *Sphenoceramus schmidti- Canadoceras multisulcatum* — Lower Campanian

underlying: Zone of *Eubostrychoceras elongatum* (lowest Camapnian to Upper Santonian)

This expression should be accompanied with careful examination of the basic data as recorded by Ward, because the local ranges of the indicated and also the associated species seem to vary considerably from place to place in the Pacific Coast. The situation is similar to (but not identical with) that in Japan described in the preceding article (3).

In Madagascar, one of the best studied areas in the Indo-Pacific Cretaceous, Collignon (1969–1970) proposed the following scheme of zonation:

overlying: Zone of *Pachydiscus gollevilensis- P. neubergicus* (Lower Maastrichtian)

(6) Zone of *Hoplitoplacenticeras marroti* — Upper Campanian

(5) Zone of *Delawarella subdelawarensis-Australiella australis*

(4) Zone of *Pachydiscus grossouvrei* — Middle Campanian

(3) Zone of *Menabites boulei-Anapachydiscus arrialoorensis*
(2) Zone of *Karapadites karapadensis* — Lower Campanian
(1) Zone of *Anapachydiscus wittekindi*
underlying: Zone of *Pseudoshloenbachia umbulazi* (Upper Santonian)

The finer subzones proposed by Collignon are omitted from the above indication. The Upper Campanian is poorly developed in Madagascar.

Now the ammonites from the studied part of northern Hokkaido listed in Table 1 contains 17 species which are distributed beyond the Japanese province. They occupy about 41% of the entire fauna, but they have mostly long vertical ranges, except for a few, and their distributional areas are mostly within the Indo-Pacific realm. No species is common with any of the species from Europe. Therefore, we have to consider at a level of a species group or a genus.

In this case the most important is the occurrence of *Hoplitoplacenticeras* species in the prolific part of the Zone of *Metaplacenticeras subtilistriatum*. *Hoplitoplacenticeras* includes a considerable number of species which occur in various regions of the world. Although a taxonomic restudy may be needed on some of them, reliable stratigraphic data show that the majority of them occurs in the lower part of the Upper Campanian and that a few of them may range up to the upper part of the same substage, as has been discussed carefully by Cobban (1963) and Howarth (1965).

In Madagascar the Upper Campanian is incompletely developed and rather poor in ammonites, but Collignon (1970) described 8 species of *Hoplitoplacenticeras*, one of which is fairly close to *H. monju* from our province. Our *H. fugen* is close to *H. marroti*, the zonal index of the lower Upper Campanian in western Europe and related provinces. Presumably, the upper Upper Campanian may be absent or represented by ammonite poor strata in Madagascar. In the same respect, I should like to know what zone comes above the Zone of *H. marroti* in Texas. It is very good to know the record of *Hoplitoplacenticeras* sp. (Cobban, 1963) coming from the Zone of *Baculites asperiformis*, where *Trachyscaphites spiniger porchi* (Adkins), a geographical subspecies of European *T. spiniger*, also occurs. Thus the correlation of the *Hoplitoplacenticeras* bearing strata in the N. American Interior Province to the lower Upper Campanian is warranted.

In the Pacific Coast province of North America, the Zone of *H. vancouverense* is placed below the Zone of *M. pacificum* and above the Zone of *B. chicoensis*. In the Japanese province *H. monju* and *H. fugen* are found within the Zone of *M. subtilistriatum* and *B. chicoensis yezoensis* occurs below the Subzone of *Schlueterella kawadai*, i.e. the lowest part of the Zone of *M. subtilistriatum*, in the Zone of *Sphenoceramus schmidti* and also in the underlying zone of *S. orientalis*.

It should be kept in mind that *M. subtilistriatum* is not identical with *M. pacificum*, although they are allied to each other, that *H. vancouverensis* is never identical with *H. monju* nor with *H. fugen*. Therefore, the corresponding species may not be strictly contemporary, although they may be nearly so.

The local range of *M. subtilistriatum* in our province seems to be longer than that of *M. pacificum* in the N. American Pacific province, as that of *S. schmidti* and that of *B. chicoensis yezoensis* are so.

Anyhow, it is reasonable to conclude that the Zone of *M. subtilistriatum* is referred to the Upper Campanian. If we take into consideration the facts in Southwest Japan metnioned

in the preceding article (3), it can be concluded that this zone represents a comparatively lower part of the Upper Campanian, if not the lower Upper Campanian in the strict sense as defined in western Europe.

It is interesting to note that *Schlueterella kawadai*, which characterize the lowest part of the Zone of *M. subtilistriatum*, is closely allied to *S. pseudoarmatum* from the Upper Campanian of Germany.

The underlying Zone of *S. schmidti-Canadoceras kossmati* is prolific but lacks the index species which occur in the standard or reference sequences in northwestern Europe and the Gulf-Atlantic province. Quite recently, Mr. Isamu Ochi, a friend of mine in Shikoku, has shown me a fragmentary specimen, which I preliminary call *Delawarella* sp. aff. *D. delawarensis* (Morton) (body-chamber), obtained from a locality which corresponds to the upper part of the Zone of *S. schmidti*. On this evidence and also on the ground of stratigraphic succession, I would refer the Zone of *S. schmidti* in the Japanese province to the upper Lower Campanian or the Middle Campanian if the Campanian is tripartite. The underlying Zone of *S. orientalis-Anapachydiscus naumanni* is tentatively referred to the Lower Campanian (s.s.), although it lacks the internationally useful guide species.

To sum up the above discussions, the megafossil zonation of the Campanian in the Japanese province is tentatively summarized as follows:

overlying: Zone of *Inoceramus shikotanensis-Neodesmoceras japonicum*

(4) Unnamed Zone
- (4c) Unnamed subzone
- (4b) Subzone of *Pravitoceras sigmoidale*
- (4a) Subzone of *Didymoceras awajiense*

(3) Zone of *Metaplacenticeras subtilistriatum*
- (3c) Unnamed subzone
- (3b) Subzone of *Hoplitoplacenticeras fugen*
- (3a) Subzone of *Schlueterella kawadai*

Upper Campanian

(2) Zone of *Sphenoceramus schmidti-Canadoceras kossmati*
- (2b) Subzone of *Canadoceras mysticum*
- (2a) Unnamed lower part

(1) Zone of *Sphenoc. orientalis-Anapachydiscus naumanni*

Lower Campanian

underlying: Zone of *Inoceramus japonicus-Eupachydiscus haradai**

*There is a debate about the Capanian/Santonian boundary (see Matsumoto & Tashiro, 1982).

(5) *Faunal Provincialism:*—The mid- to late Campanian ammonite fauna of northern Hokkaido, as listed in Table 1, is composed generally of the predominant Indo-Pacific elements. Especially, a considerable number of species are common between the Japanese and the North American Pacific Coast provinces, although some of them are distributed in still wider areas. Examples are *Neophylloceras ramosum, N. hetonaiense, Desmophyllites diphylloides, Canadoceras mysticum, Pseudophyllites indra, Diplomoceras notabile, Ryugasella ryugasensis, Baculites subanceps pacificus, B. inornatus* and *B. chicoensis*, although the last one with a subspecific difference.

There are, however, many species which are so far known only from the Japanese province, although some of them are allied to the North American species. Examples are *Anapachydiscus fascicostatus, Menuites sanadai, Pachydiscus soyaensis* (allied to *P. neevesi*), *P. sahekii, Canadoceras kossmati* (allied to but somewhat older than *C. newberryanum*), *C. multicostatum, C.*

minimum, Metaplacenticeras subtilistriatum (allied to *M. pacificum*), *Hoplitoplacenticeras monju, H. fugen, Saghalinites teshioensis, Gaudryceras crassicostatum, G. mamiyai, Polyptychoceras pseudogaultinum, Schlueterella kawadai, Parasolenoceras tomitai, P. periodicum* and *Baculites kotanii*. Although there may be some collection failure, the above fact shows a provincial differentiation in the Campanian time even within the North Pacific region.

Lastly it should be noted that various Campanian species of the Kossmaticeratidae which occur characteristically in the southern part of the Indo-Pacific realm are almost absent in the North Pacific region.

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Kanji or Kana for Place Names

Abeshinai 安平志内, Abeshinai-Rubeshibetsu アベシナイ ルベシベツ, Asan 阿 讃,
Awaji 淡 路, Chikubetsu 築 別, Embetsu 遠 別, Haboro 羽 幌, Hakobuchi 函 淵,
Haranosawa 原ノ沢, Hetonai 辺富内, Hobetsu 穂 別, Ikandai 井寒台,
Ikushumbets 幾春別, Izumi 和 泉, Kiyohama-I 第一清浜, Kiyohama-II 第二清浜,
Koishi 小 石, Kotanbetsu 古丹別, Magaribuchi 曲 淵, Maru-yama 丸 山,
Matsuyama 松 山, Mikasa 三 笠, Naibuchi 内 淵, Nakagawa 中 川, Nakamura 中 村,
Nakato 中 通, Nishinotoro 西能登呂, Nutapetokoma ヌタペトコマ, Obira 小 平,
Ohmisaki 大 岬, Orannai 尾蘭内, Osoushinai オソウシナイ, Oyubari 大夕張,
Penkezawa ペンケ沢, Ryugase 龍ケ瀬, Saku 佐 久, Saku-gakko-no-sawa 佐久学校の沢,
Sanuki 讃 岐, Shimanto 四万十, Soya 宗 谷, Tanno-sawa 炭ノ沢, Teshio 天 塩,
Togushi 十 串, Tombetsu 頓 別, Tomiiso 富 磯, Tomiuchi 富 内, Tshashikots シャシコツ,
Tsukisap [Tsukisappu] 月 寒, Urakawa 浦 河, Uttsu ウッツ, Wakkanai 稚 内,
Wembets-Rubeshbe ウエンベツ ルベシュベ, Yasukawa 安 川, Yezo エ ゾ

Index of Genera and Species

This index contains names of the genera, subgenera, species and subspecies described or discussed in the Systematic Descriptions of Part I (I/page) and Part II (II/page) of this paper. Plates are indicated by boldface type followed by a number of a figure (as **15**, 1 = Pl. 15, Fig. 1).

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