

The Bituberculate Pachydiscids from Hokkaido and Saghalien : Studies on the Cretaceous Ammonites from Hokkaido and Saghalien-VIII

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The Bituberculate Pachydiscids from Hokkaido and Saghalien

**(Studies on the Cretaceous Ammonites
from Hokkaido and Saghalien-VIII)**

By

Tatsuro MATSUMOTO

Introduction

In a previous number of the serial papers on the Cretaceous Ammonites from Hokkaido and Saghalien (T. MATSUMOTO *in* T. M. [Editor] 1954) I have monographed some of the important members of the Pachydiscidae from Hokkaido and South Saghalien. They are mainly the "normal Pachydiscids" in which tubercles are developed only along the umbilical margin. There are, however, forms which have, in addition to the umbilical tubercles, ventrolateral and also sometimes median ones on the venter. They are conventionally called bi- and tri-tuberculate Pachydiscids.

Now the bi- or tri-tuberculation appears in a number of different phylogenetic groups, so that careful studies are required for the natural classification of such forms. Indeed we have a good many examples of homoeomorphy in ammonite palaeontology, but I cannot deny at the same time another tendency, for a particular kind of specialization to take place more frequently in a particular family than in others. Thus a parallelism of a small scale is often found within one and the same family, apart from that on a major scale among the different families. As is demonstrated in the following pages the bi- or tri-tuberculation in the Pachydiscidae can be regarded as such a case.

Lytodiscoides, which was once regarded as a Pachydiscid, and the closely allied *Achilleoceras* are bi- and tri-tuberculate Puzosiids, as has been remarked in my monograph of the Puzosiidae (1954b, p. 55, and 109). However in that family bi- or tri-tuberculation is very rare and never appears in the immature stage. The Kossmaticeratidae have more numerous examples of bi- or tri-tuberculate forms which are morphologically analogous but of different ages. Examples are, as discussed in another paper (T. MATSUMOTO, 1955), *Eomadrastes* and *Neomadrastes* or *Holcodiscoides* and *Yokoyamaoceras*.

Among the bituberculate Pachydiscids *Menuites* (i.e. the group of *Ammonites menu FORBES*) is well known. The genus in a revised definition given below is now proved

to have been derived from *Anapachydiscus* and ranges from Santonian up to Maestrichtian. COLLIGNON's *Besairietes* is a synonym of *Menuites* but there is around '*Pachydiscus*' *rotalinoides* YABE a group of bituberculate forms related to *Eupachydiscus*. Another example is a new genus, which is intimately connected with Campanian *Canadoceras* or with Coniacian-Santonian *Nowakites*. I can point out, furthermore, other bituberculate forms which are probably related to *Pachydiscus* (s.s.) [= *Parapachydiscus* Hyatt]. On the other hand, as WRIGHT and MATSUMOTO (1954, p. 124) have already mentioned, certain species of Turonian *Lewesiceras* "exhibit strengthening of the ribs on the shoulders and the midline of the venter", and the tendency might have given rise to trituberculate forms such as *Ammonites rosalinus* STOLICZKA (1865, p. 65, pl. xxxiv, fig. 2; KOSSMAT, 1898, p. 91 [156], pl. xiv [xx], fig. 3a, b). The same species was recorded from Madagascar under the generic name of *Pachydiscus* (BOULE, LEMOINE & THÉVENIN, 1907, p. 25, pl. vi, fig. 5, pl. vii, fig. 1). A doubtful genus *Pseudojacobites* may be a trituberculate Turonian Pachydiscid, since *Ammonites rosalinus* much resembles '*Pachydiscus*' *farmeryi* CRICK (1910, p. 345, pl. xxvii, figs. 1, 2), the type species of *Pseudojacobites* SPATH, 1922. To the same genus I have referred (T.M., 1943, p. 219), with a query another Indian species, '*Pachydiscus*' *anapadensis* KOSSMAT (1898, p. 90 [155], pl. xiv (xx), fig. 2) [= *Ammonites peramplus* STOLICZKA (non MANTELL), 1865, p. 130, pl. lxxv, figs. 1, 2]. That species has distinct ventrolateral tubercles in the last whorl and is a bituberculate example, related more intimately to *Lewesiceras*. In spite of the efforts since SHIMIZU's proposal of *Rotalinites* (1935, p. 181), which is now regarded as a synonym of *Pseudojacobites*, Japanese palaeontologists have failed to obtain good specimens of *Lewesiceras* and of the related bi- or tri-tuberculate forms from the Turonian of Hokkaido and Saghalien. Therefore I treat in this paper mainly the Senonian forms. For a better understanding of the bituberculate Pachydiscids I shall discuss the taxonomy and evolution of some of the normal Pachydiscids.

A fact which should be mentioned here is that the bituberculate Pachydiscids are as a rule much smaller than the related normal ones.* In other words a new character was added to the immature of the corresponding normal Pachydiscids. This may be an example of neoteny (in the proper sense, cf. G. R. DE BEER [1951]), while physiologically paedogenesis (acceleration of sexual maturity) may have taken place. It is of course rather difficult to tell the growth-stages of ammonites, but we have great many specimens of large or gigantic 'normal Pachydiscids', while the bituberculate ones are always small or moderate (<125 mm in diameter) in size. The ventral tubercles are mostly developed in the body chamber of what is probably the adult shell and sometimes begin to appear earlier in growth-stages. A constriction and associated elevated rib characterize the apertural margin, where the ventral tubercles are again

* A doubtful but possible exception is *Ammonites complexus* HALL & MEEK (MEEK, 1876, p. 447, pl. xxiv, fig. 1a-c), but I have at present no definite idea about its systematic position. [After Dr. COBBAN by his kind personal communication.]

lost. Some examples have an aptychus in the shell aperture. These features perhaps indicate maturity in spite of the small size.

Someone might consider the 'bituberculate' and 'normal' forms as sexual dimorphism, but the occurrence in the field and the presence of immature bituberculate examples suggest generic difference. There may be perhaps some ecological significance in the morphologic characters, but our present knowledge does not allow a conclusion on this problem.

Ammonite body chambers are apt to be destroyed or crushed during sedimentation and fossilization. Even if the body chamber is in a favourable state of preservation, the inner whorls are sometimes crushed owing perhaps to the incomplete petrifaction. Such unfavourable circumstances are especially serious for the proper identification of the bituberculate Pachydiscids. Scaphitoid coiling is suggested by the outer whorls of certain specimens, but, in my opinion, this is only apparent and is due to poor preservation.

The specimens to be described in this paper are mainly those of my own collection and partly those of the collections of H. YABE (1909, 1915), M. KAWADA (1929) and S. NAGAOKA (purchased). They are preserved partly in the Department of Geology, Kyushu University (GK) and partly in the Geological Institute, University of Tokyo (GT). A few specimens in the Geological and Palaeontological Institute, Tohoku University, Sendai (IGPS) have been examined too. As to the localities and horizons of the described specimens the reader is requested to refer to the stratigraphic papers entitled: "Fundamentals in the Cretaceous Stratigraphy of Japan" (T. MATSUMOTO 1942-43) and also "The Cretaceous System in the Japanese Islands" (T. MATSUMOTO [Editor], 1954). After I had prepared the first draft of this paper I visited London and had an opportunity to examine specimens which are preserved in the British Museum (Natural History) (BM) and in the Geological Survey & Museum of Great Britain (GSM).

Acknowledgements

I am indebted in the first place to Mr. C. W. WRIGHT of London who has kindly read through the typescript and has given me valuable criticisms and suggestions. I wish to thank Professor T. KOBAYASHI of Tokyo University where I have freely studied specimens from Mr. M. KAWADA's collection, as well as from my own one; Professor Emeritus H. YABE and Professor K. ASANO through whom I have had access to the original specimens preserved in the Geological and Palaeontological Institute, Tohoku University; and General M. COLLIGNON who has given me information about certain ammonites from Madagascar. To the authorities of the British Museum (Natural History) who have rendered facilities in that Museum, where I have been able to work through a British Council Scholarship and to Dr. L. F. SPATH of that institution my thanks are due, as they are likewise to the staff of the Geological Survey & Museum

of Great Britain, especially Dr. R. V. MELVILLE.

The photographs at the University of Tokyo have been taken by Mr. C. UEKI and at Kyushu University by myself with the kind assistance of Mr. I. OBATA. Miss Junko TAKAMIYA has helped me in the preparation of the manuscript. Mr. K. NAKAZAWA of Kyoto University has kindly sent me a photocopy of a paper which is inaccessible here.

Systematic Descriptions

Superfamily Desmocerataceae

Family Pachydiscidae

Genus *Menuites* SPATH, 1922

Type species by original designation *Ammonites menu* FORBES, 1846 (from Southern India).
Synonym, *Besairietes* COLLIGNON, 1931.

Generic diagnosis.— Shell, of small or moderate size, similar to the inner whorls of *Anapachydiscus* YABE and SHIMIZU, 1926 in form, ribbing, umbilical tuberculation and sutures, but provided with the ventrolateral tubercles, typically on and near the adult body chamber. The bituberculation sometimes begins to develop at a fairly early stage. The aperture is constricted and the accompanied raised rib has no ventrolateral tubercles. Aptychus is found at least in some form.

Remarks.— The genus was proposed by SPATH (1922, p. 123) as follows: "A bituberculate development, derived from the more globose forms of the genus *Parapachydiscus*, leads to *Ammonites menu* FORBES, with scaphitoid coiling; this development is here separated as *Menuites*." *Parapachydiscus* in this sense includes true *Pachydiscus* GROSSOUVRE, 1894 [= *Parapachydiscus* HYATT, 1900], a group of the compressed forms, in which the ornamentation is differentiated into numerous ventral ribs and less numerous umbilical tubercles or tuberculated ribs, and another group of inflated forms. The latter may indeed in part have a close connexion with the former, but can mostly be removed to *Anapachydiscus* YABE and SHIMIZU, 1926. That genus, redefined by myself (1947, 1951 and 1954) has been made familiar by, for instance, COLLIGNON's monograph (1952) and SPATH's recent paper (1953). It is characterized by the inflated and depressed whorls throughout life and relatively weak costae or subcostae especially in the immature and typically also in the adult stages. It is long-ranged and perhaps the fundamental stock of the Senonian Pachydiscids.

As is described below, *Menuites menu* (FORBES) and its allies are very like the inner whorls of *Anapachydiscus* of corresponding size. In fact the shells of *Menuites* before the bituberculate stage are hardly distinguishable from immature shells of *Anapachydiscus*. It is very difficult to tell whether a small form like '*Pachydiscus*' *cricki* KOSSMAT (1898, p. 105 [170], pl. xv (xxi), fig. 3a, b, c) is an immature *Anapachydiscus* or *Menuites*. While the full-grown *Anapachydiscus* reaches a large or huge size, *Menuites* stops its growth at a diameter of 125 mm or below.

The well known species *Menuites menu* (FORBES) came from the Valudayur beds, probable Upper Campanian or Maestrichtian, of Southern India and *M. portlocki* (SHARPE) from the *mucronata* zone of Northern Ireland, England and Northern Germany. As will be explained below in more detail, the Indian species seems to be connected with *Anapachydiscus fascicostatus* (YABE) and the Northwest European one is possibly related to *Anapachydiscus wittekindi* (SCHLÜTER).

We have in Hokkaido and Saghalien three Santonian representatives of *Menuites*. The first of the three forms is very similar to *M. portlocki* (SHARPE) but intimately related to *Anapachydiscus deccanensis* (STOLICZKA); the second is connected with *Anapachydiscus sutneri* (YOKOYAMA); the third is an extremely small species somewhat resembling *M. selbiensis* (PERVINQUIÈRE) of Tunisia and is similar to a certain *Anapachydiscus*. Besides them there are two other forms, of higher horizon, which are comparable to *M. sturi* (REDTENBACHER) from the Alpine Gosau beds and to *M. menu* (FORBES) respectively.

In my definition *Menuites* is, thus, a group of bituberculate derivatives straight from various forms of *Anapachydiscus*. The species of the so-called *Menuites* other than those mentioned above are removed in this paper to other genera.

Kossmaticeras pseudorotalinus COLLIGNON (1931, p. 18, pl. i, fig. 7, 7b, pl. viii, fig. 10) from Madagascar is, in my opinion, a relatively widely umbilicate *Menuites*, so that *Besairieites* COLLIGNON, 1931 (p. 19), which was proposed for that species, is probably a synonym of *Menuites*.

I have discussed with Dr. SPATH the question of the so-called 'scaphitoid coiling' of *Menuites*. The illustrated specimen of *M. menu* (FORBES) (BM. R10482), which has a nearly complete adult body chamber, shows no sign of scaphitoid coiling (fig. 1). In another specimen (BM. C47549), of similar size, the umbilicus is covered with compact rock-matter and has a short joint-like line of demarcation, which forms an apparent scaphitoid curve combined with the outline of the umbilical margin (fig. 2). The specimen is rather delicate in preservation, so that we have hesitated to develop completely the questionable portion, but from the umbilical tubercles of the inner whorl which crop out from the matrix it seems that the coiling was in a normal spiral. This conclusion is confirmed by specimens of other species. The modification is only found in the deformed specimens.

Distribution.—*Menuites* is known, though not abundant, in South India, Japan, Saghalien, Madagascar, Egypt (?), Tunisia and Europe (both Alpine and northwestern areas). It ranges from Santonian to Campanian (possibly further up to Maestrichtian).

Menuites cf. *menu* (FORBES)

Pl. 32, fig. 6.

Compare:—

1846. *Ammonites menu* FORBES, p. 111, pl. 10, fig. 1a, b, c.

1865. *Ammonites menu*, STOLICZKA, p. 103, pl. lii, fig. 4.

1898. *Pachydiscus menu*, KOSSMAT, p. 104 [169].

1922. *Menuites menu*, SPATH, p. 123.

Description.— Two imperfectly preserved specimens, GT. I-2773 [=“Cr. 1382”] from Onnenai, Hokkaido (no record of collection) and GT. I-525 from Shimaiwa-zawa, Shimaiwa shale (bed Rdy), Naibuchi Valley, South Saghalien (M. KAWADA Coll.).

The body chamber, though somewhat deformed, resembles well the bituberculate part of the Indian specimens of *M. menu*; the whorl before the bituberculate stage has rounded distant umbilical nodes, faint subcostae and striae or very fine riblets. The shell-form is depressed and inflated. Thus in all the observable characters the form in question is best comparable with *M. menu*, but its incomplete preservation and rare occurrence prevent exact identification. It is however worthy of note that the extension of the Indian species eastward to Japan and adjacent area is suggested by the present form.

FORBES' original specimens came from the Valudayur beds of Pondicherry district, South India, being probably of Upper Campanian or Maestrichtian age. A comparable form was reported once (ECK, 1914, p. 185) from the Upper Cretaceous of Egypt. One of our specimens came from the Neohetonaian (Maestrichtian) in South Saghalien. Anyhow further collection of better material is wanted.

I should like to add here a short remark on the Indian species. KOSSMAT (1898, p. 104 [169]) compared *Menuites menu* (FORBES) with *Anapachydiscus arrialoorensis* (STOLICZKA). Indeed that species may be an ally, but it has much coarser ribs than *M. menu* which, in turn, has only striae and faint riblets besides the tubercles and the apertural constrictions. On studying several specimens of *M. menu* at the British Museum (e.g. BM. R10482, lectotype here designated [=FORBES, 1846, p. iii, pl. 10, fig. 1a, b], re-illustrated in text fig. 1a-c; BM. C47549, text fig. 2a-c; BM. C47550, text fig. 3a, b), I have recognized their close resemblance to the inner whorls of *Anapachydiscus fascicostatus* (YABE) from the Urakawan of Hokkaido and Saghalien (in YABE and SHIMIZU, 1921, p. 57 (5), pl. viii (i), fig. 5; pl. ix (ii), figs. 2a, b, 3, 4, 5) (T. MATSUMOTO in T.M. [Editor], 1954, p. 273, pl. vii (xxiii), fig. 3a, b), except for the ventrolateral tubercles and the apertural constrictions. The suture* of *M. menu*, which is very finely incised even in a comparatively immature shell (as seen, for instance in a syntype, BM. C47549, at a diameter of 37 mm.), also resembles that of *A. fascicostatus* in every detail.

Menuites japonicus sp. nov.

Pl. 31, figs. 1a-c, 2a-d, 3a, b; Pl. 33, figs. 2a-d, 3a-c;

Text figs. 4a, b, 5a-c.

Material.— Several specimens of fairly good preservation, their body chamber, however,

* The suture-lines are not exposed in the lectotype, so FORBES' illustrated suture (1846, pl. 10, fig. 1c) may have depended on another specimen.

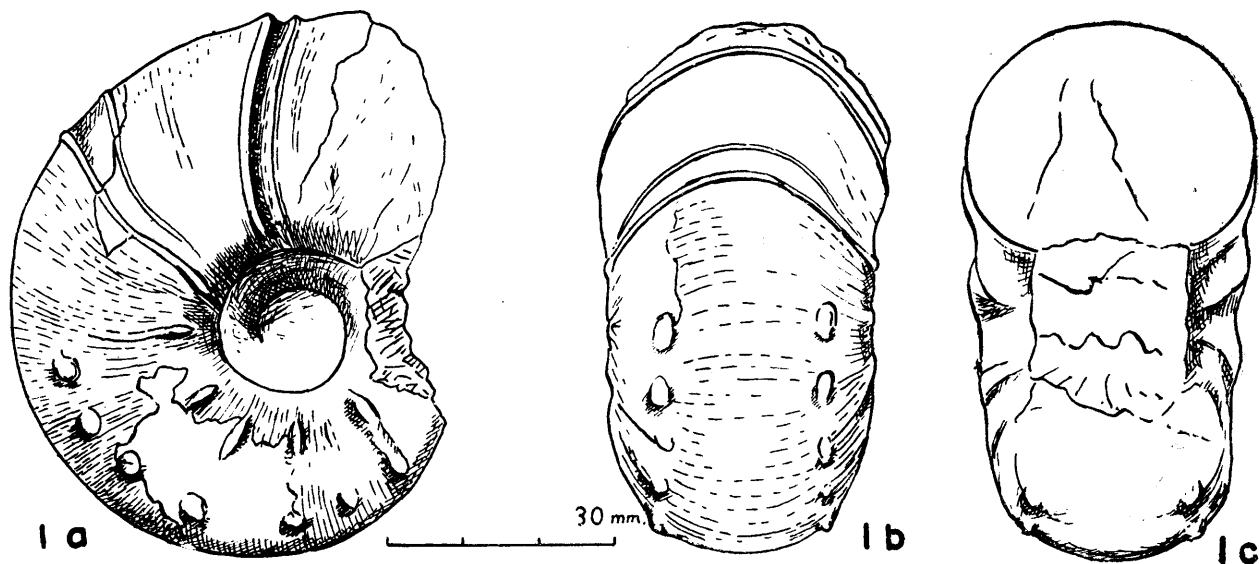


Fig. 1. *Menuites menu* (FORBES). Lateral (a), ventral (b) and apertural (c) views. Lectotype, BM. R. 10482 from Pondicherry, Valudayur beds, India, the same specimen illustrated by FORBES 1846, pl. 10, fig. 1. T.M. del. by kind permission of Keeper of Geology, British Museum (Natural History).

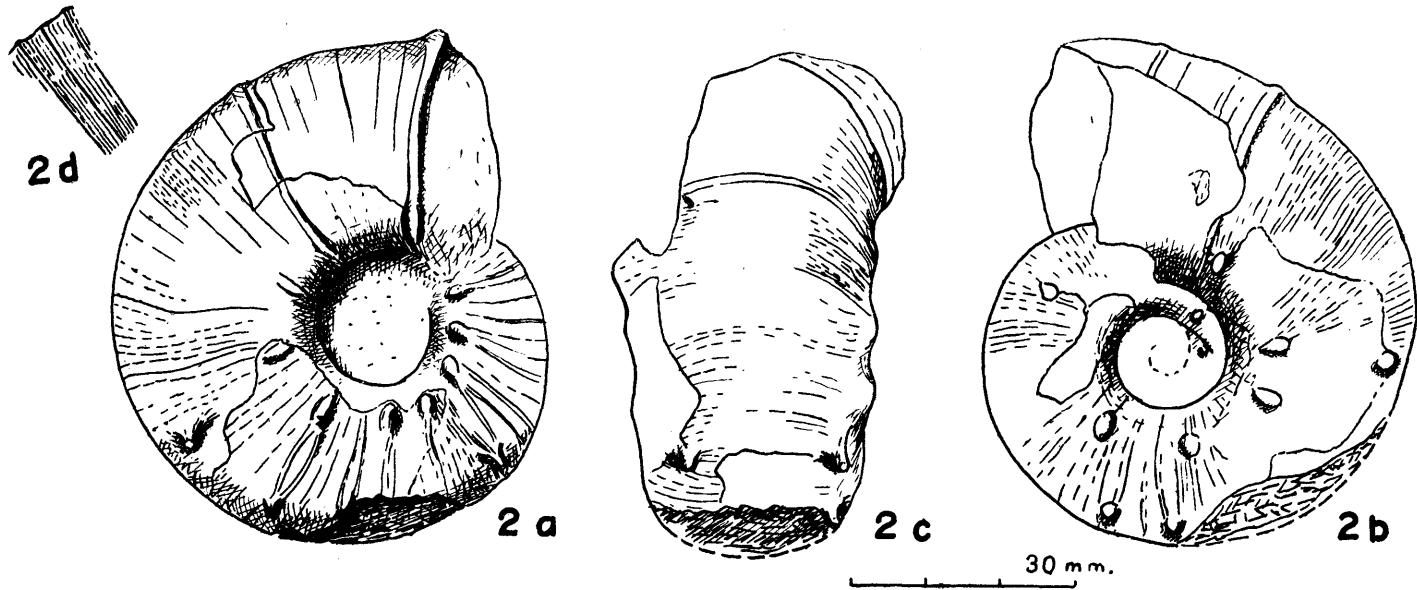


Fig. 2. *Menuites menu* (FORBES). Two lateral (a, b) and ventral (c) views. Surface of the shell, partly magnified (d). BM. C. 47549 from Pondicherry, Valudayur beds, India. T.M. del. by kind permission of Keeper of Geology, British Museum (Natural History).

being often deformed. Holotype, GT. I-3462 from locality T277c, along the Abeshinai, near the mouth of the Tannosawa, bed III d, Teshio Province, Hokkaido (T. MATSUMOTO Coll.). Paratypes, GT. I-3471, loc. T956p, bed III d of the same valley; GT. I-2771, loc. N466f, zone Mh6 (horizon Mh6 $\alpha \cdot \beta$) of the Naibuchi Valley (T.M. Coll.); GT. I-526 and GT. I-536 from the main course of the Naibuchi, South Saghalien (M. KAWADA Coll.).

Specific diagnosis.— Thickly discoidal shell, fairly narrowly and deeply umbilicate; whorls are depressed and inflated throughout life with the greatest breadth nearly at mid-height, proportion between breadth and height being more than 1.3.

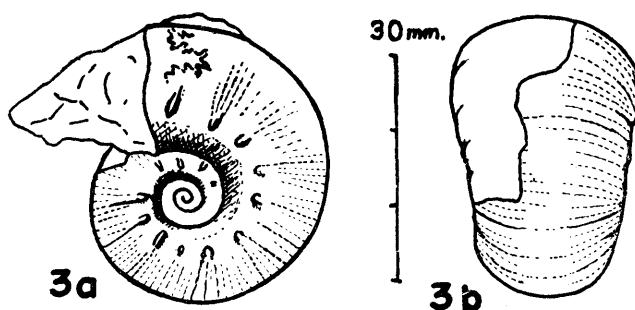
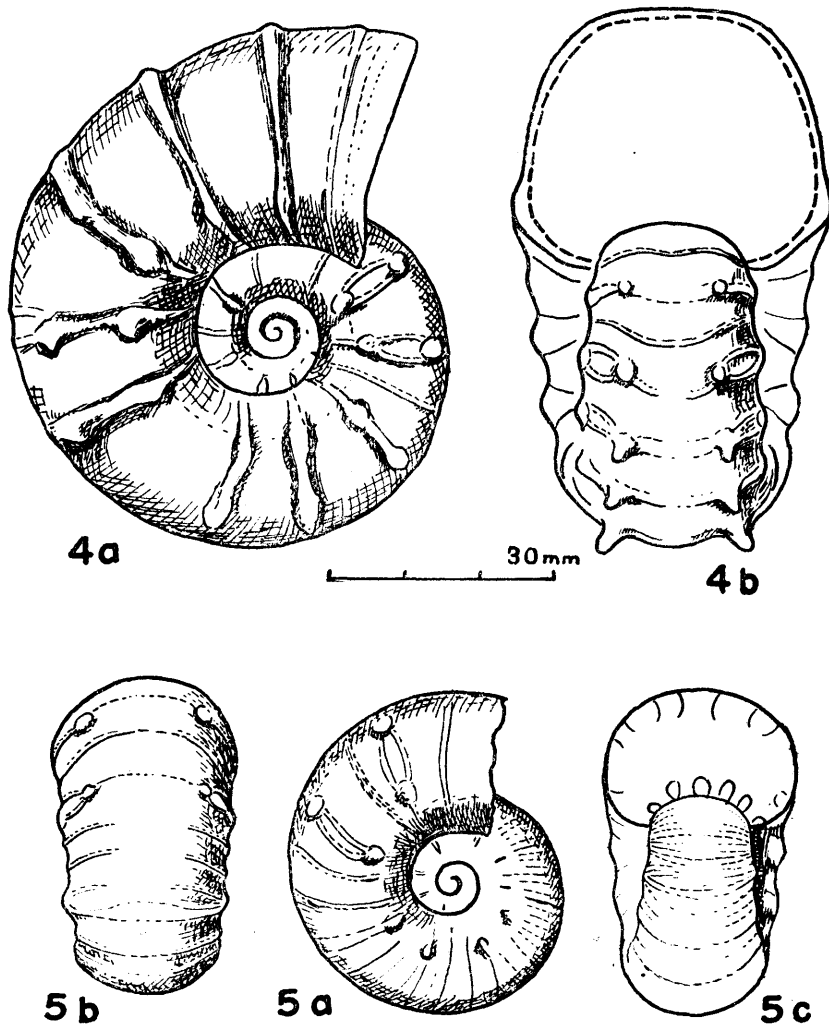


Fig. 3. *Menites menu* (FORBES). Lateral (a) and ventral (b) views of an immature example, BM. C. 47550 from Pondicherry, Valudayur beds, India. FORBES' illustrated suture-line (1845, pl. 10, fig. 10) may have depended on that exposed near the anterior end of this specimen.

The shell in the early immature stage, at diameters below several millimeters, is almost smooth and only faintly constricted; at diameters from 7–8mm. to about 22mm. it is characterized by the *cricki* type of ornamentation, namely, periodic small bullae at the rounded umbilical border, which are radially extended for a short distance as faint wavy elevations, and fine, weak and dense riblets and striae. In the late immature or middle growth-stage up to a diameter of about 35mm. occur ribs of discernible or moderate strength; two or three of them are united at the rounded, large base of the periodic lower-lateral (or umbilical) tubercles and two or three intermediate ribs are not attached to the tubercle; some interstitial minor riblets are partly discernible. The ribs show very gentle forward bend near the periphery and cross the mid-venter with decreasing strength. They are moderately distant, being separated by wider interspaces. This type of ornamentation continues typically for slightly more than one third of a whorl. Then comes the bituberculate stage which continues for about two thirds of a whorl up to a diameter of about 65mm. and occupies the last portion of the septate whorls and the main part of the adult body chamber. It is characterized by rather broad and low, distant, radial ribs, each of which is provided with inner lateral (or umbilical) and outer (ventro-) lateral tubercles. The tubercles have rounded

bases and, on the well preserved shell, are often septate and spinose. The ribs are sometimes doubled between the two lateral tubercles and usually much weakened on the venter. Some interstitial faint riblets are occasionally discernible between the tuberculated major ribs. The apertural part of the body chamber has two distant, strong



T.M. del.

Figs. 4, 5. *Menuites japonicus* sp. nov.

4. Lateral (a) and apertural (b) views of a restored adult shell. 5. Lateral (a), ventral (b) and apertural (c) views of the inner whorl. The restoration is based mainly on holotype and partly on other specimens.

ribs which have bullate umbilical tubercles and only obscure ventrolateral angulations instead of tubercles.

The suture-line is similar to that of *Anapachydiscus fascicostatus* (YABE) of corres-

ponding size (e.g. T. MATSUMOTO, *in* T.M. [Editor] 1954, pl. vii [xxiii], fig. 3a, b). The last septum is found in the early part of the bituberculate stage. The body chamber occupies about two thirds of a whorl but the character of the actual apertural margin is not precisely known.

*Measurements**.—

Specimen	Diameter	Height	Breadth	(B/H)	Umbilicus (%)
GT. I-3462	>70(deformed)				
(undeformed septate part)	42.5	18.75	25.7	(1.37)	11.0 (25.8)
GT. I-2771	{ >55(deformed)				
	—	18.5	25.3	(1.37)	—
GT. I-3471	33.5	16.5	23.5	(1.42)	7.7 (23)
	23.0	10.5	16.0	(1.52)	
	16.5	7.8	11.2	(1.43)	
GT. I-536	36.5	17.7	23.6	(1.33)	9.0 (25)

Remarks.— The shell of the present species before the bituberculate stage is very similar to the form which has been called *Anapachydiscus yezoensis* (YABE MS.). That Neourakawan (i.e. approximately Santonian) form, which was described concisely in a Japanese paper (T. MATSUMOTO, 1947, p. 41), resembles so closely *Anapachydiscus deccanensis* (STOLICZKA) (1865, p. 126, pl. lxiii, fig. 1) that I am now inclined to regard it as a subspecies of the Indian form, as will be redefined below in the Appendix of the present paper. Anyhow *Menuites japonicus* is very possibly a derivative from that form. *A. deccanensis yezoensis*, which has no ventrolateral tubercles at any stage, reaches a far larger size when full-grown and its ribs of moderate strength appear somewhat later than in *M. japonicus*.

The specimens of the present species enumerated above were provisionally listed under the name of *Menuites* aff. *menu* (FORBES) in my stratigraphic papers (T.M. 1942–43; T.M. [Editor], 1954), but through the comparison with the original specimens of the Indian species I have confirmed that *M. japonicus* is distinguished from *M. menu* (FORBES) by its more distinct ribbing in the late immature stage, more definite elevation between the umbilical and ventrolateral tubercles and somewhat longer duration of the bituberculate stage.

On the other hand I have been strongly impressed by its resemblance to another foreign species, *Menuites portlocki* (SHARPE) (1855, p. 30, pl. xiii, figs. 2, 3) from the *mucronata* zone (Campanian) of Northwest Europe, since I saw the British original specimens (GSM. 37247 and GSM. 37246). However the European species has coarser and more distant ribs and has ventral tubercles appearing somewhat later than our species. In *M. portlocki* the normally ribbed stage continues much longer and the ribs are weakened gradually near the bituberculate part. The bituberculate body chamber is provided with very distant, broad and low elevations between the two lateral tubercles.

* Measurements are in millimeter.

This feature in the adult stage is similar to that of the present species, but the two raised, transverse ribs seen near the shell-aperture of the present species have not yet been confirmed in the British specimens, probably because of their incomplete preservation. The European species, when full grown, may reach somewhat larger size than ours, as is suggested by the German specimens (GRIEPENKEL, 1889; WOLLEMAN, 1902). In brief, *M. portlocki* (SHARPE) is, though fairly similar to *M. japonicus*, probably connected with such a form as *Anapachydiscus* [?] *wittekindi* (SCHLÜTER) 1876, p. 160 [= *Ammonites robustus* SCHLÜTER 1872, p. 67, pl. xxi, figs. 1-8; pl. xxii, figs. 1-3], which has coarser ribs than *A. deccanensis* (STOLICZKA). It seems better to regard our form as specifically distinct from *M. portlocki* than to assume it to be a geographical subspecies of the Northwest-European form, since no connecting forms have been found between the much separated provinces; the two forms under consideration are also geologically of different ages.

Occurrence.— Bed IIIId (*Anapachydiscus* zone) (upper part of the Upper Yezo group) of the Abeshinai-Saku area, Teshio Province, Hokkaido and zone Mh6 of the Naibuchi Valley, South Saghalien: Neourakawan (approximately Santonian).

Menuites naibutiensis sp. nov.

Pl. 33, fig. 1a-d.

Holotype.— GT. I-424, from Juhachi-rinpan-ninosawa, a tributary of the Naibuchi, Miho group (exact horizon uncertain but presumably zone Mh6), South Saghalien (M. KAWADA Coll.), with a diameter of about 70mm.; the anterior part of the body chamber is not preserved.

Diagnosis.— Rather small, depressed *Menuites*, whose immature shell is ornamented with numerous, weak ribs and periodic umbilical nodes. On the adult body chamber the ribs are obsolete, while prominent lower lateral and ventrolateral tubercles with large, rounded bases are well developed; the two kinds of tubercles being connected by a very faint, but wide radial elevation; one umbilical tubercle corresponds usually to one but occasionally to two ventrolateral ones. The ventral area between the two rows of peripheral tubercles is wide and the tuberculated, faint, radial elevations are very distant. Radial striae are discernible on both the low, major elevations and the interspaces.

Remarks.— Although the species is only represented by a single specimen, it has its own unmistakable characteristics. Before the bituberculate stage the present species is closely similar to *Anapachydiscus sutneri* (YOKOYAMA) (1890, p. 187, pl. xxiii, fig. 1a-c; T. MATSUMOTO in T.M. [Editor], 1954, p. 276, pl. vii (xxiii), figs. 1a, b, 2a, b) of corresponding size. It is somewhat similar to *M. japonicus* described above, but the radial elevations which connects the two lateral tubercles are much lower and the ribs before the bituberculate stage are more crowded and more numerous. There may be

some difference in the shell-form, just as seen between *A. sutneri* and *A. fascicostatus*, but the deformed condition of the holotype prevents us from the accurate comparison. To clarify that point and also its exact horizon further collecting is wanted.

Menuites pusillus sp. nov.

Pl. 32, figs. 1a-d, 2a-d, 3a-c, 4a, b.

Material.— Several small, fairly well preserved specimens. Holotype, GK. H3382 from loc. U505, Ikandai, bed Ur1 β , Urakawa area, Hidaka Province, Hokkaido (T. MATSUMOTO Coll.). Paratypes, GK. H3381 from loc. U506, bed Ur1 β , Urakawa area (T.M. Coll.); GT. I-2772 [= "Cr 1446"], exact locality uncertain, Urakawa area, presumably Upper Yezo group, no record of collection; IGPS. 54436, from the Sanushibe (about 200 m. above the confluence of Sakuranosawa), 'Pachydiscus beds' of YABE, Iburi Province, Hokkaido (NISHIKAWA Coll.). The last specimen seems to be the one which was described, but not illustrated, by H. YABE (1915, p. 21) under the name *Pachydiscus rotalinoides* YABE.

Specific diagnosis.— Very small *Menuites*, with depressed whorls, fairly narrow and deep umbilicus, rounded umbilical margin, inflated flanks and broadly arched venter. The late immature stage at diameters of 10 to 20 or 25mm. is ornamented with numerous weak riblets, weak major ribs along the faint, periodic constrictions and distant lower lateral tubercles. This immature ornament is succeeded directly the bituberculate ornament of the adult type, which continues about two thirds of the last whorl. Finally near the aperture appear one or two raised transverse ribs with accompanying faint constrictions and without ventral tubercles. The bituberculate stage is characterized by the distant, broad, major, radial ribs on which usually ventrolateral and inner lateral tubercles are arranged. The tubercles are spinose, when the shell is well preserved, and have rather rounded base on the internal mould. Some of the major ribs show a very gentle forward curvature on the venter but some others run nearly transversely with decreasing strength. A few faint, minor riblets are sometimes found between the major ribs and the shallow constrictions in front of the major ribs are hardly discernible or only partly discernible, while doubling of the major rib is often found between the inner and outer tubercles.

Suture-lines of immature *Anapachydiscus* type.

*Measurements**.—

Specimen	Diameter	Height	Breadth	(B/H)	Umbilicus (%)
GK. H3382	24.2	10.0	13.0	(1.3)	6.3 (26)
GK. H3381	21.0	9.5	12.5	(1.3)	4.8 (23)
(intercostal)		9.2	11.0	(1.2)	

* The measurements are on the undeformed part, usually near the mid-substage of the bituberculate shell. The diameter of the full-grown stage is somewhat larger than the above, but smaller than 40mm.

GT. I-2772 (costal)	37.7	16.0	22.3	(1.4)	10.3 (27)
(intercostal)	36.3	15.0	20.0	(1.3)	9.7 (27)
IGPS. 54436	25.0	11.2	16.0	(1.4)	6.4 (25)

Remarks.— In spite of their small size, the specimens before me are considered as adult or nearly mature shells from the characters of the body chamber. The present species is fairly closely allied to the contemporary *Menuites japonicus* described above, but is much smaller and has the *koluturensis* type of ornament succeeded directly by the bituberculate stage, without intercalation of the stage of *yezoensis* type of ornament. In other words the new character, bituberculation, appears earlier than in other species and was apparently associated with extreme acceleration of sexual maturity in the present species.

On the other hand the present form is somewhat similar to *Anapachydiscus* (*Neopachydiscus*) *naumanni* YOKOYAMA in the depressed whorl, development of broad and low major ribs with associated faint constrictions and minor riblets, etc. However the two forms under consideration differ considerably, if we compare the specimens of the same size.

In connexion with a small form like the present species a remark should be given on *Menuites selbiensis* (PERVINQUIÈRE) (1907, p. 177, pl. vii, figs. 13a–b, 14a–b, 15a–b, 16, 17a–b, 18a–b, 19a–b, 20, 21, 22a–b). All the described specimens of Tunisia are very small. Although PERVINQUIÈRE pointed out that *selbiensis* might be a transition from a ‘*Pachydiscus*’ (like *P. cricki* KOSSMAT) to ‘*P. menu*’, he compared specimens of different sizes. Typical *Menuites menu* (FORBES) from India does not show any sign of bituberculation in the inner whorls of such a small size. Presumably the Tunisian specimens are still immature, so that the bituberculation observed in one specimen (pl. vii, fig. 22) can be said to have appeared earlier than in *menu* itself. Our forms in question is not identical with that Tunisian species, because its bituberculation is far more distinct in the corresponding size and the *koluturensis* type of ornament clearly characterizes the immature stage. In the appearance of the fairly distant ribs the Tunisian form seems to resemble the immature of *M. japonicus*. Anyhow more material from Tunisia is wanted for a decisive conclusion.

In my Japanese paper of 1947 and other stratigraphical papers (1942–43, 1954) the specimens of the present species were listed, together with those belonging to *M. japonicus*, under the name *Menuites* aff. *menu* (FORBES) but the distinction is now clear.

Occurrence.— Neourakawan (approximately Santonian) of the Urakawa and other areas in Hokkaido.

Menuites aff. *sturi* (REDTENBACHER)

Pl. 32, fig. 5a, b.

Compare:—

1873. *Scaphites* [?] *sturi* REDTENBACHER, p. 129, pl. xxx, fig. 10.

- ? 1890. *Pachydiscus aurito-costatus*, SEUNES (non SCHLÜTER), p. 447 (239), pl. viii, fig. 4a-c.
1894. *Pachydiscus sturi*, GROSSOUVRE, p. 197, textfig. 79.

Description.— A small and deformed specimen (GK. H3380a) and another fragmentary one (GK. H3380 b) from loc. U513, bed Ur2 β' , Ikandai-gawa, Urakawa area, Hidaka Province, Hokkaido (T.M. Coll.).

The deformed specimen is about 25mm. in the greatest diameter. Its outer whorl is depressed and has inflated flanks, broadly arched venter, rounded umbilical margin and umbilicus of a moderate size. It has near its anterior margin two distant constrictions and associated, narrow, raised ribs, which are much elevated at the umbilical border. About a quarter of a whorl behind that portion is nearly smooth, being only ornamented with very fine riblets or 'striae' and a weak constriction. The next posterior quarter of a whorl develop five, distant, radial ribs with inner and outer tubercles. The ribs are low and much weakened on the venter. The body chamber occupies about two thirds of the outer whorl from this portion. The preceding septate part is again nearly smooth, only with growth-striae, very faint and fine riblets and small umbilical bullae. The characters of the still inner whorls are unknown.

Another fragmentary specimen is comparable with the tuberculate portion of the above. The two specimens came from the same nodule in bed Ur2 β' , which belongs to the zone of *Inoceramus orientalis*-*Anapachydiscus* (*Neopachydiscus*) *naumanni*, Infracampanian (approximately Lower Campanian).

In its very small size and its general characters the form under consideration is somewhat allied to *Menuites pusillus* described just above. However the former has a wider umbilicus, a shorter bituberculate stage and a much longer, nearly smooth part between the bituberculate part and the constricted apertural portion. In this respect it resembles rather a form which was described under the name of *Scaphites* (?) *sturi* REDTENBACHER from the Senonian of the Alpine region. That species was later removed to *Menuites* by SPATH (1922, p. 123), when he established the genus. The apparent scaphitoid shape of the Alpine specimen may be due to the deformed condition as in the case of the present form. The suture of the European form is, as pointed out by GROSSOUVRE (1894, p. 197, text fig. 79), of Pachydiscid type. Similarly our form exhibits the suture of the immature *Anapachydiscus*. Only three bituberculate major ribs are described in REDTENBACHER's specimen, while five are recognized in the Japanese form. However there may be a certain extent of variation in that respect.

Genus *Urakawites* nov.

Type species.— *Pachydiscus rotalinoides* YABE, 1915.

Generic diagnosis.— Resembling *Menuites* but has less inflated and less depressed whorls, with height not much different from breadth and much stronger and coarser ribs.

Remarks.— The bituberculate '*Pachydiscus*' *rotalinoides* YABE, a Paleohetonaian (Campani-

an) species redefined below, has less depressed whorls and stronger ribs than typical *Menuites*, being, accordingly, much more similar of *Eupachydiscus* than to *Anapachydiscus*. Besides the type species another North Pacific species, '*Pachydiscus*' *binodatus* WHITEAVES, is referable to the genus under consideration, being closely allied to *Eupachydiscus perplicatus* (WHITEAVES). *Urakawites* is thus a group of bituberculate forms which are probably related to *Eupachydiscus*.

A specimen of *Ammonites auritocostatus* SCHLÜTER, 1872, figured in 1867 (= *Ammonites proteus* SCHLÜTER, 1867, p. 20, pl. iii, fig. 2a, b, c) may be an example of *Urakawites* from the Campanian of Germany, since it has strong and fairly distant ribs as in *U. rotalinoides* (YABE).

Now *Eupachydiscus* itself is intimately connected with *Anapachydiscus*, so that *Urakawites* might include, besides the direct derivatives from *Eupachydiscus*, also bituberculate offshoots of certain *Anapachydiscus*, whose trend is close to *Eupachydiscus*. '*Menuites*' *macgowani* HAUGHTON (1925, p. 268, pl. xiii, figs. 1, 2, 3) from Angola seems to suggest such a case, but the available evidence is not sufficient enough to decide accurately the systematic position of this African species. For the time being it is referred to the present genus with a query.

Distribution.— Campanian of Japan, Saghalien and Pacific side of North America; doubtfully Senonian of Angola and Campanian of Germany.

In connexion with *Urakawites* I must give a remark on the compressed forms of the bituberculate Pachydiscids. The group is represented by *Pachydiscus ambiguus* GROSSOUVRE (1894, p. 198, pl. xxix, fig. 3) [= *Ammonites auritocostatus* SCHLÜTER, 1872, pl. xxii, figs. 6, 7 non 4, 5] and *Ammonites hallemensis* SCHLÜTER (1867, p. 19, pl. iii, fig. 1, 1872, p. 70; NOWAK, 1913, p. 349) from the Upper Senonian of Europe. Although I have not yet examined the European specimens themselves and have failed to discover any comparable forms from our province, I am rather inclined to regard them as a *Menuites*-like offshoot from *Pachydiscus* [= *neubergicus-gollevillensis* group] in view of their much compressed whorls and the minor, ventral ribs. SPATH has already remarked (1922, p. 122) that the compressed *Pachydiscus* (i.e. *Parapachydiscus* in his 1922 paper) may tend to differentiate ornamentation on the ventrolateral edges. This tendency might later produce forms with ventrolateral tubercles. A French specimen (GROSSOUVRE, 1894, pl. xxix, fig. 3) seems to reveal such tubercles. STOLICZKA (1865, p. 104, pl. liii, fig. 2, 2a) has illustrated a bituberculate example which seems to be intimately connected with the typical form of *Pachydiscus egertoni* (FORBES). That Indian specimen may require a new specific name, but the available material is not sufficient enough to give a clear definition.

Among the "compressed forms of *Menuites*" (SPATH, 1922, p. 123) there is one more doubtful member of the group under consideration. That is '*Menuites*' *auritocostatus* (SCHLÜTER) from the Upper Senonian of Germany. Of the three specimens illustrated

under that specific name, *Ammonites proteus* SCHLÜTER (*non d'* ORBIGNY) (1867, p. 20, pl. iii, fig. 2a, b, c) seems to belong to *Urakawites*, as I have mentioned just above. The second specimen (SCHLÜTER, 1872, pl. xxii, figs. 4, 5), which has several riblets, might either be specifically identical with the first or represent a different species allied to '*P.*' *ambiguus* GROSSOUVRE, to which the third specimen is referred. As the specimens are described as being somewhat deformed and their figures are restored, I hesitate to give a conclusive remark.*

Anyhow from the taxonomic necessity I propose here a new generic name for the "compressed *Menuites*" under consideration with the following definition.

Genus *Pseudomenuites* nov.

Type species.— *Pachydiscus ambiguus* GROSSOUVRE, 1894** (from the Upper Senonian of Europe).

Generic diagnosis.— Very similar to *Pachydiscus* in the compressed shell-form and the type of ornaments, but provided with ventrolateral tubercles in more or less later whorls. The lateral ribs which connect the umbilical and ventrolateral tubercles are sometimes strong, while minor ventral ribs are found on the interspaces. Suture-line of *Pachydiscus* type.

Distribution.— Upper Senonian of Europe and India (?).

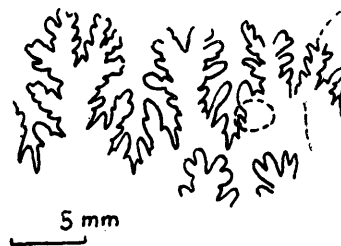
Urakawites rotalinoides (YABE)

Pl. 34, figs. 1a–c, 2a, b, 3a, b; Pl. 35, fig. 2a–d;

Pl. 37, fig. 1a–c; Text figs. 6, 7a, b.

1915. *Pachydiscus rotalinoides* YABE, p. 21, pl. i, fig. 9, pl. ii, fig. 5a, b, 6a, b.

Types.— YABE (1915) established this species on the basis of several syntypes. Of the three figured specimens of different sizes two better ones came from Hokkaido and a fragmentary one from Toyajo, Wakayama Prefecture [=Province Kii], Honshu. Although his 1915-paper was intended to report the fossils from Toyajo and Anaga of Southwest Japan, the description of that species doubtlessly depended much on the better preserved specimens from Hokkaido, so that I designate here the specimen (IGPS. 54438) from Urakawa (YABE 1915, p. 21, pl. ii, fig.



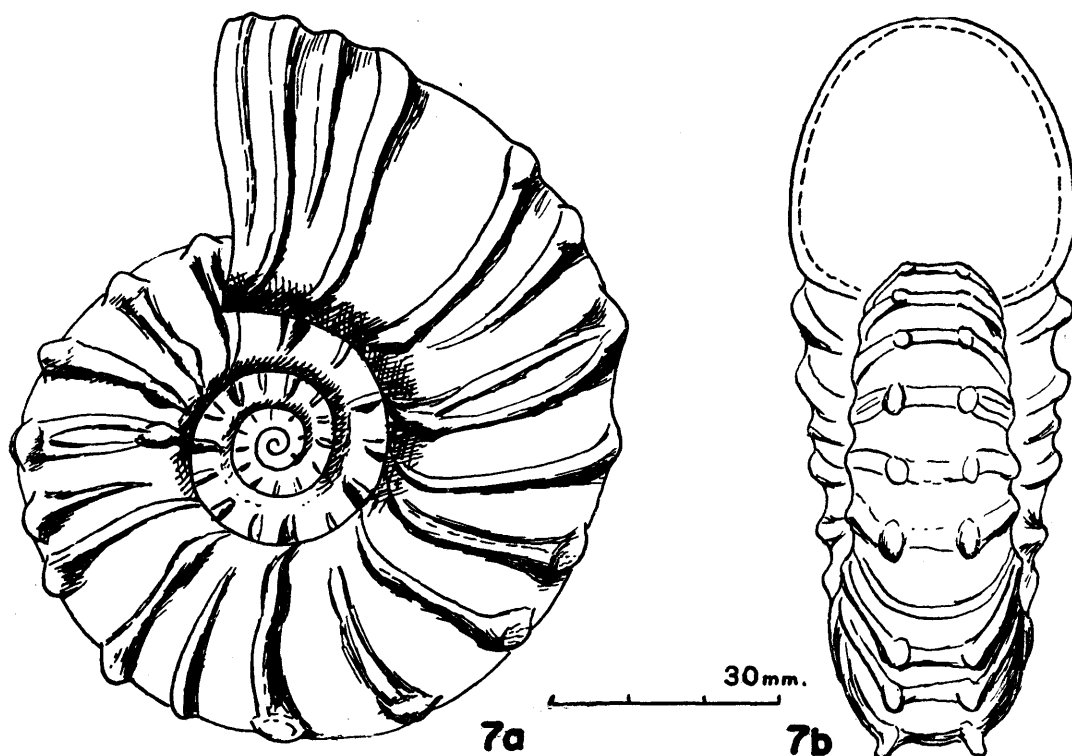
T.M. del.

Fig. 6. *Urakawites rotalinoides* (YABE). External suture-line of lectotype, IGPS. 54438, in the middle growth-stage.

* For the first step to unravel the complexity I would designate the first specimen (SCHLÜTER, 1867, p. 20, pl. iii, fig. 2a, b, c) as the lectotype of *Urakawites* (?) *auritocostatus* (SCHLÜTER).

** GROSSOUVRE (1894) did not designate the holotype of the species. His species was based on a fragmentary German specimen (*Ammonites auritocostatus* SCHLÜTER, 1872, pl. xxii, figs. 6, 7 *non* 4, 5) and another French one (GROSSOUVRE, 1894, p. 198, pl. xxix, fig. 3a, b) in moderate state of preservation. To clarify the definition I designate here the latter as the lectotype of the species.

5a, b) as lectotype. Although YABE's illustration does not clearly show the character of the inner whorls, the specimen itself, which I have fortunately borrowed from Tohoku University, now shows more clearly the specific characters than before (Pl. 34, fig. 1a-c). Furthermore there are in my own collection the following specimens which are referred to the present species:— GK. H3385 from loc. U9, bed Ur4 β and GK. H3383, loc. U600c26, bed Ur3, both in the Urakawa area, Hidaka Province, Hokkaido; GT.



T.M. del.

Fig. 7. *Urakawites rotalinoides* (YABE). Lateral (a) and apertural (b) views of the adult shell, synthetized illustration.

I-3464, (loc. T522p), GT. I-3465 (loc. T944c), GT. I-3469 (loc. T280), GT. I-3467 (loc. T727), GT. I-3470 (loc. T943), etc. all from bed IIIe (zone of *Inoc. schmidtii-Canadoceras kossmati*) of the Abeshinai-Saku area, Teshio Province, Hokkaido; GT. I-2774 from loc. N428c bed Ray 1 (zone of *Inoc. schmidtii-Canadoceras kossmati*) and other comparable specimens from the same bed in the Naibuchi Valley, South Saghalien. One of YABE's syntypes, IGPS. 54436 from Sanushibe, should be removed from the present species (see the description of *Menuites pusillus*).

Specific diagnosis.— Thickly discoidal shell of fairly small or moderate size; umbilicus deep and nearly 30% ($\pm 2\%$) of diameter; involution about one third; whorls almost

as high as broad or slightly broader than high, trapezoidal in costal section with a greatest breadth in the dorsal part. Some distant ribs before the bituberculate stage. The coarse ribs and ventral tubercles begin to develop usually when the diameter of the shell exceeds 20mm., but occasionally in somewhat earlier or later stage.

The major ribs are generally simple, very coarse, separated by wider interspaces on which a few minor ribs are occasionally, but not always, found. They are rather straight but often show a considerable forward bend near the periphery. Two pairs of tubercles are usually developed on each major rib; one at the periphery and the other on the rounded umbilical border. The distance apart, across the venter, of the two peripheral ones is somewhat less than that between the ventral and umbilical ones. The tubercles are spinose on the well preserved shell and thickly nodose at their base; the base of the ventral one is typically rounded but sometimes clavate and that of the umbilical one is also rounded and sometimes bullate. Occasionally the ribs bifurcate near the umbilical tubercle or a rib is intercalated without an umbilical but with a ventral tubercle. The ribs are mostly weakened on the venter between the peripheral tubercles.

A specimen (GT. I-2774) (Pl. 37, fig. 1a-c) about 100mm. in diameter has, near the apertural part of its adult body chamber, major ribs with weak umbilical tubercles but no ventral ones and cross the venter keeping their strength, accompanied by narrow and shallow constrictions. The aperture is provided with an aptychus, which is unfortunately poorly preserved.

Sutures are of the same pattern as in *Anapachydiscus*, and especially in *Eupachydiscus haradai*, of corresponding size. The relatively less incised suture of the lectotype (fig. 6) owes its character to immaturity and also to poor preservation.

Measurements.—

Specimen	Diameter	Height	Breadth	(B/H)	Umbilicus (%)
IGPS. 54438	55.3	23.0	29.5	(1.28)	14.5 (26.2)
(deformed)	45.5	19.8	24.9	(1.26)	12.0 (26.3)
GT. I-3469	53.0	21.8	25.8	(1.18)	15.0 (28.3)
GT. I-2774	96.0	38.0	36.0	(0.94)	29.5 (30.7)
GK. H3385	53.4	20.4	26.3	(1.24)	17.0 (31.8)
for comparison:					
<i>Menuites pseudorotalinus</i> (COLLIGNON) estimated from the figures					
	40.4	15.0	22.3	(1.48)	16.2 (40.1)

Remarks.— The present species is distinguished from species of *Menuites* (e.g. *M. menu* (FORBES), *M. portlocki* (SHARPE), *M. japonicus* sp. nov., etc) by its less depressed, if not much compressed, whorls, stronger and coarser ribs and bituberculation of longer duration. It is fairly closely allied to some species of *Eupachydiscus* (e.g. *E. haradai* (JIMBO)) in shell-form, sutures and strong ribbing, but has distinct ventral tubercles from a fairly early growth-age and its ribs in the bituberculate stage are much more distant than those of *Eupachydiscus* of corresponding size. The specimens before me, including YABE's

originals, are mostly rather small, being 70mm. or below in diameters, but a single specimen (GT. I-2774), which can well be regarded as the full-grown shell, reaches nearly 100mm. Even that is still far smaller than the adult shells of *Eupachydiscus*.

The present species has been said to be closely allied to or possibly identical with "*Kossmaticeras* (*Besairietes*)" *pseudorotalinus* (COLLIGNON) (1931, p. 18, pl. i, fig. 7, 7a, 7b; pl. viii, fig. 10) from the 'Upper Santonian-Lower Campanian' of Madagascar. However the Malgash form has much depressed whorls and wider umbilicus than ours and, furthermore, does not develop the strong ribbing of *Eupachydiscus* type. Since it is not a member of *Urakawites* but probably referred to *Menuites*, *Urakawites* can not be synonymized with *Besairietes*.

Dr. YABE (1915) remarked on the affinity of the present species with *Ammonites rotalinus* STOLICZKA (1865, p. 65, pl. xxxiv, fig. 2; KOSSMAT 1898, p. 91 [156], pl. xiv [xx], fig. 3a, b). The proper systematic position of that species is, indeed, still problematic but I have no further evidences to alter the opinion which was mentioned in connexion with *Rotalinites* SHIMIZU 1935, an abandoned generic name (see WRIGHT & MATSUMOTO, 1954, p. 124). The two forms are probably an example of a small scale homoeomorphy within the same family.

Occurrence.—Lectotype is from Urakawa, probably "*Pachydiscus* beds", Hokkaido. The "*Pachydiscus* beds" of YABE may be either *Anapachydiscus* zone or *Canadoceras* zone of MATSUMOTO. My collection from the same area has furnished other examples from the zone of *Canadoceras kossmati*. YABE's two syntypes are from the probable "*Pachydiscus*" bed of Kikumezawa, Ishikari Province, Hokkaido and from the Toyajo formation of Wakayama Prefecture. In my collection of Hokkaido and South Saghalien all the specimens came from the zone of *Inoceramus schmidtii*-*Canadoceras kossmati*, Paleohetonaian (approximately Upper Campanian). In our present knowledge the fossiliferous main part of the Toyajo formation is also referred to Paleohetonaian.

Urakawites aff. *binodatus* (WHITEAVES)

Pl. 35, fig. 1a, b.

Compare:—

1903. *Pachydiscus binodatus* WHITEAVES, Mesoz. Fossils, Vol. I, pt. v, p. 347, pl. 49, fig. 1, 1a; text fig. 23.
1952. *Pachydiscus binodatus* WHITEAVES, USHER, p. 86, pl. 21, figs. 1, 2; pl. 31, fig. 9.

Description.—A single but fairly well preserved specimen, GK. H5200, is before me. Its dimensions are as follows.

Diameter	Height	Breadth	(B/H)	Umbilicus (%)
55.0	24.0	26.5	(1.1)	14.0 (25.3)

In shell-form the present form is very similar to *Eupachydiscus haradai* (JIMBO) of corresponding size and, accordingly, also to *Urakawites rotalinoides* (YABE), except for its somewhat smaller umbilicus. Furthermore the specimen has on its outer whorl

strong ribs and prominent umbilical tubercles quite similar to those of the middle-aged *E. haradai* and on what is probably the body chamber nodose elevations of the ribs at the ventrolateral periphery. The ribs cross the venter without notable weakening, though with slight flattening. In the bituberculate stage the ribs are somewhat more distant than in the middle-aged shell of *E. haradai*.

The specimen from Hokkaido is closely allied to '*Pachydiscus*' *binodatus* WHITEAVES from the Nanaimo group of Vancouver Island, but is much smaller than that Canadian form if we compare the bituberculate stages. It may possibly be a dwarf of WHITEAVES' species. Now, as the Canadian authors have remarked, '*P*' *binodatus* WHITEAVES is closely allied to '*P*' *perplicatus* WHITEAVES (1903, p. 346, pl. 48, fig. 1; USHER, 1952, p. 77, pl. xii, fig. 1; pl. xiii, figs. 4-6; pl. xiv, figs. 1-3; pl. xv, figs. 1, 2; pl. xxxi, fig. 5). The latter resembles *Eupachydiscus haradai* (JIMBO) and its ally *E. teshioensis* (JIMBO) (see T.M. in T.M. [Editor], 1954, p. 286) and could be synonymized with, or regarded as a subspecies of, either of the two. Anyhow '*P*' *binodatus* WHITEAVES is an example of *Urakawites* and the intimate relation between *Eupachydiscus* and *Urakawites* is again demonstrated by both the Canadian and Japanese forms.

Occurrence.— Exact locality uncertain in Teshio Province, associated with *Inoceramus schmidtii*, Hokkaido (S. NAGAOKA Coll., purchased).

Genus *Teshioites* nov.

Type species.— *Teshioites ryugasensis* sp. nov. (described below).

Generic diagnosis.— Closely allied to *Canadoceras* in shell-form, sutures, ribbing, umbilical tubercles and periodic constrictions, but has ventrolateral tubercles on the adult whorl, which is of moderate or small size.

Remarks.— Besides the type species there is another species of the present genus. The two species occur in the Paleohetonaian (approximately Upper Campanian) of Hokkaido and Saghalien.

Teshioites has more compressed whorls, less inflated flanks, more narrowly arched venter and much more distinct and frequent constrictions than *Menuites* and *Urakawites*. Its fairly strong ribs are numerous even in the bituberculate stage. The distance between the two ventral tubercles in *Teshioites* is shorter than that in *Menuites*. The umbilical tubercles tend to be gradually weakened in the adult of *Teshioites* as in the late growth stage of *Canadoceras*, while they are very distinct in *Menuites* and *Urakawites*, being as strong and often as spinose as the ventrolateral tubercles.

As is demonstrated below, the type species is so closely allied to *Canadoceras kossmati* (YABE MS.) MATSUMOTO of corresponding size that the two genera are doubtlessly intimately related. *Canadoceras* is a member of Pachydiscidae but has no direct connexion with *Anapachydiscus*. On the other hand *Menuites* is intimately related to *Anapachydiscus*, as has already been remarked. *Urakawites*, a probable derivative from *Eupachydiscus*,

can be said to have a cennexion with *Anapachydiscus*, since *Eupachydiscus* is closely allied to *Anapachydiscus**.

Thus on both morphological and genetical grounds, *Teshioites* is distinguished from *Menuites* and from *Urakawites*.

Coniacian-Santonian *Nowakites* is a probable ancestor of Campanian *Canadoceras*. Whether *Teshioites* is derived from *Nowakites* in parallel to *Canadoceras* or directly from *Canadoceras* itself is still uncertain. Both cases are possible, since *Canadoceras* is intimately connected with *Nowakites*.

Nowakites is considered to have given rise to *Pachydiscoides* as a special offshoot. Certain members of that genus, e.g. *Pachydiscoides hourcqui* COLLIGNON (1952, p. 26, pl. iii, figs. 1, 1a, 1b, 2, 2a, 2b), seem to have a tendency to strengthen the peripheral edge of the ribs, if not to form distinct tubercles. Apart from such forms, one of the specimens (a paratype) of "*Nowakites savini*" (GROSSOUVRE, 1894, p. 152, pl. xxxvii, fig. 4a, b) does show unmistakable bituberculation, resembling the second species (*T. teshioensis* sp. nov. described below) from our province. This might be an example of *Teshioites* derived from *Nowakites*, but GROSSOUVRE described the date of the French specimen as being uncertain and I have no reliable information to decide the precise relation between the holotype and the paratype of *savini*.

Distribution.— Campanian of Hokkaido and Saghalien. In view of the presence of a comparable form in France and of the fairly wide distribution of *Canadoceras* and *Nowakites*, further studies might show wider geographical distribution and geological range of *Teshioites*.

Teshioites ryugasensis sp. nov.

Pl. 36, figs. 1a, b, 2a, b; Pl. 37, fig. 3a, b; Text fig. 8a, b.

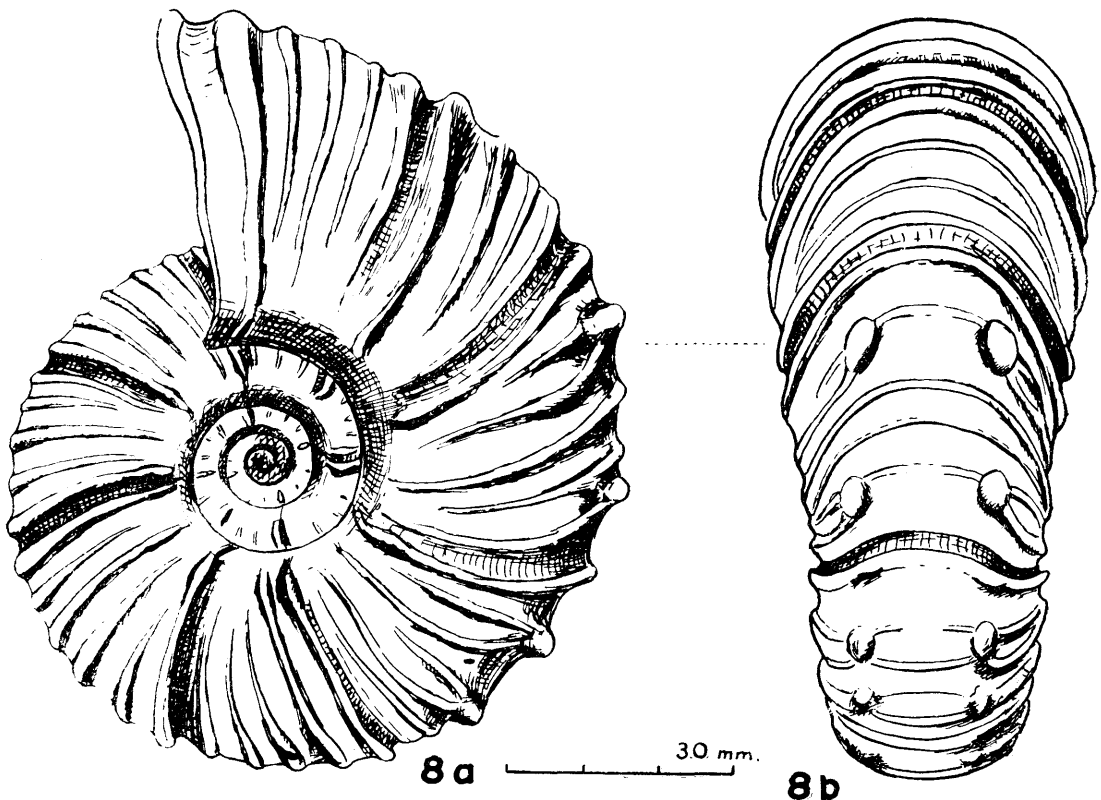
Material.— Holotype, GT.I-3488, from loc. T472p, Tannosawa, a tributary of the Abeshinai, bed IIIe (*Inoceramus schmidtii* zone), Teshio Province, Hokkaido (T. MATSUMOTO Coll.). Paratypes, GT. I-3475 from the same nodule as the holotype; GT. I-3473 from loc. T731 p2, Nio-no-sawa, Abeshinai-Saku area, Teshio Province, Hokkaido (T.M. Coll.); other comparable specimens, GT. I-2775a, b from loc. N472r, bed Rayl, (T.M. Coll.), GT. I-2776 (M. KAWASAKI Coll.) and GT. I-2779 [=Cr. 546] (M. KAWADA Coll.), Ryugase Gorge (bed Ray) of the Naibuchi Valley, South Saghalien.

Specific diagnosis.— Discoidal shell of moderate size, with fairly narrow umbilicus (25–29% of the diameter). Whorls slightly higher than broad in the later growth-stage, with the greatest width somewhat below the mid-height and a little above the umbilical shoulder; umbilical wall nearly perpendicular (in the body chamber) or fairly steep (in other parts); umbilical shoulder abruptly bent but rounded; flanks gently

* For example, *Anapachydiscus fascicostatus* → *A. deccanensis yezoensis* → *Eupachydiscus teshioensis* → *E. haradai* is one of the possible serial changes between the two genera.

convex and venter moderately arched.

Except in the very early growth-stage, there are frequent constrictions and numerous ribs, which are slightly flexuous on the flanks and bent moderately forward on the venter. The constrictions are well marked in the middle growth-stage, but less so in the bituberculate part of the body chamber. The ribs associated with the constrictions and also a few intermediate ones are long and strong and have, on crossing



T.M. del.

Fig. 8. *Teshioites ryugasensis* sp. nov. Lateral (a) and ventral (b) views of the adult shell, synthesized illustration.

the umbilical shoulder, prominent bullate tubercles. The other ribs are of moderate strength, free from tubercles and rather short, but arise near the umbilical shoulder.

On the body chamber lateral ribs are still frequent, being separated by the interspaces as narrow as the ribs. In the anterior half or so of the adult body chamber a pair of ventral tubercles are developed typically on each two ribs, the two lateral ribs forming a loop at the tubercles; while on the venter a pair of tubercles are connected usually by a single rib. The distance between the two ventral tubercles is much shorter than that between the umbilical and peripheral ones. In the last portion of the septate whorl, just behind the distinctly bituberculate body chamber, a pair of

slight elevations are found on each rib at the ventrolateral shoulders. The apertural part of the body chamber is ornamented again by numerous ribs without ventral tubercles and a few periodic constrictions; the umbilical tubercles on the longer ribs are gradually weakened.

Suture-lines of the same pattern as those of *Canadoceras kossmati*, being finely incised in the adult.

Measurements.—

Specimen	Diameter	Height	Breadth	(B/H)	Umbilicus (%)
GT. I-3488	>95 (deformed adult)				
(septate part)	76	35.5	32	(0.95)	19.5 (26)
GT. I-3475(inner whorl)	45	20.5	19.5	(0.95)	12 (27)
GT. I-3473	100	42.0	41.0	(0.97)	27.5 (28)
($\frac{1}{2}$ earlier)	—	30.5'	29.5	(0.97)	18.0 (—)
($\frac{3}{4}$ earlier)	56	25.0	24.4	(0.97)	15.8 (28)

Remarks.— The present species closely resembles *Canadoceras kossmati* (YABE MS.) MATSUMOTO (1954, p. 295, pl. xiii [xxix], fig. 1a, b; pl. xiv [xxx], figs. 1, 2; pl. xv [xxx], fig. 1; pl. xvi [xxxii], figs. 1, 2a, b, 3a, b, 4a, b; text-figs. 18–25 [64–71]; 27 [73]) up to a diameter of about 70mm.* In the succeeding stage the two are similar in shell-form and costation, but the present species has characteristically bituberculate ribs, looped in pairs at the tubercles. The adult shell of the present species is about 100mm. in diameter, while *Canadoceras kossmati*, which is free from ventral tubercles at any stage, continues to grow further on up to a very large size, the largest example which I have ever seen being 650mm. in diameter.

In one specimen, GT. I-3473 (Pl. 36, fig. 2a, b) of beautiful preservation, the ventral tubercles are much weaker than in the normal form and are developed on a very limited portion of the body chamber. Accordingly the specimen is very similar in aspect to the middle-aged shell of *Canadoceras kossmati*, being morphologically an intermediate form.

From the above described facts the present species is most probably derived from *C. kossmati* by the addition of a new character (bituberculation and some related modification of ribs) to the middle stage of that species.

Geologically the two species are nearly contemporary, both occurring in the zone of *Inoceramus schmidtii*, although *C. kossmati* is more common than *T. ryugasensis*. Further careful subzonal collection might show successive occurrence of the forms under consideration.

Occurrence.— Palaeohetonaian (approximately Upper Campanian) of Hokkaido and Saghalien.

* In my Japanese paper of 1947 (p. 44) a very brief remark was given about the present species under the name of *Menuites ryugasense* MATSUMOTO MS. However the remark was mainly done in comparison with *Canadoceras kossmati* (YABE MS.), which was then nomenclatorially invalid. Therefore I should regard that description as too incomplete to validate the specific name *ryugasensis* from that date.

Teshioites teshioensis sp. nov.

Pl. 37, fig. 2a, b; Pl. 35, fig. 3a-c.

Material.— A few specimens, more or less imperfectly preserved, but exhibiting their own characteristics. Holotype, GT. I-3466 from loc. T908 p2, a pebble of the Kurumizawa, a tributary of the Abeshinai, derived from bed IIIe, *Inoc. schmidtii* zone, Teshio Province, Hokkaido (T. MATSUMOTO Coll.). Paratypes, GK. H5212, Teshio Province, (no further record of collection, purchased from S. NAGAOKA) and GT. I-3461 from loc. T313, Wakkawembets, Abeshinai, bed IIIe (*Inoc. schmidtii* zone), Teshio Province, Hokkaido (T. M. Coll.).

Specific diagnosis.— A relatively small *Teshioites*, whose outer whorl is slightly broader than high and fairly narrowly or moderately umbilicate. Periodic constrictions show a forward ventral projection. The numerous ribs of moderate strength and of unequal length are separated by interspaces slightly wider in the earlier part and markedly wider in the later part. There are umbilical tubercles at the end of the longer ribs, nodose at first, bullate later, especially so on the raised ribs along the constrictions; ventrolateral tubercles appear in the middle stage (i.e. the late part of the septate whorls) on each rib or on each two ribs and continue on the main part of the body chamber with increasing strength. Two lateral ribs often branch at the umbilical tubercle and are looped occasionally at the ventrolateral ones. The ventral area between the rows of the peripheral tubercles tends to be flattened and the ribs connecting them are weakened and tend to be straightened, except the ribs along the constrictions which cross the venter without notable weakening. A few narrowly raised, transverse elevations and associated constrictions occur near the apertural margin of the body chamber. The sutures are similar to those of *Canadoceras kossmati* or *yokoyamai* of corresponding size.

Measurements.—

Specimen	Diameter	Height	Breadth	(B/H)	Umbilicus (%)
GT. I-3466	43.0	19.2	21.0	(1.1)	11.3 (26.3)
GK. H5212	39.0	15.3	7.1	(1.1)	11.7 (30.0)

Remarks.— Up to a diameter of about 35mm. the shell of the present species is hardly distinguishable from the immature shell of *Canadoceras yokoyamai* (JIMBO) (1894, p. 31 [177], pl. ii [xviii], fig. 3, 3a, 3b) (emended by T.M., in T.M. [Editor], 1954, p. 302, pl. xiii [xxix], fig. 2a, b; pl. xvii [xxxiii], figs. 1a, b, 2; text fig. 26), but the small size and bituberculation in the adult stage are the criteria. A paratype (GT. I-3461), with a diameter of approximately 45mm., has after the bituberculate stage a few raised, transverse ribs and constrictions at its anterior end and is therefore regarded as adult.

The present species is allied to *Teshioites ryugasensis* described above but has relatively broader whorl and is smaller. In the former species the bituberculation appears earlier and the constrictions keep their distinctness even in the bituberculate stage.

In other words the more accelerated appearance of the new character seems to characterize *Teshioites teshioensis* as compared with *T. ryugasensis*.

At first sight the present species somewhat resemble *Urakawites rosalinoides* (YABE) but has more numerous, more crowded and more elevated ribs before the bituberculate stage, and well-marked constrictions, periodic raised ribs and less distant and narrower ribs in the bituberculate stage.

One of the paratypes, GK. H5212, of the present species is very similar to a paratype of "*Nowakites savini*" (GROSSOUVRE) (1894, p. 26, pl. xxxvii, fig. 4a, b) from an uncertain horizon of the Upper Cretaceous of France. The French specimen is, in my opinion, specifically distinct from the holotype of the true *Nowakites savini* (GROSSOUVRE) (1894, p. 26, pl. xxv, fig. 4a, b) and is probably an European example of *Teshioites*, perhaps allied to, but more compressed than, the present species. However, as the specimen in question is somewhat deformed and as I have not yet examined sufficient number of specimens, I hesitate to propose a new specific name for it.

Occurrence.— Palaeohetonaian (approximately Upper Campanian) in Teshio Province, Hokkaido.

Summary

As a summarized result I present here a list of the bi- and tri-tuberculate Pachydiscids which have been described or discussed above. The page reference in brackets is to this paper.

Pseudojacobites SPATH, 1922

(Probable bi- and tri-tuberculate derivatives of *Lewesiceras*, Turonian) (p. 154)

P. farmeryi (CRICK) [Type species] (Upper Turonian of England) (p. 154)

P. rosalinus (STOLICZKA) (Turonian of India and Madagascar) (p. 154 and p. 172)

P. [?] anapadensis (KOSSMAT) (Turonian [?] of India) (p. 154)

Menuites SPATH, 1922 [= *Besairietes* COLLIGNON, 1931]

(Typically the bituberculate derivative of *Anapachydiscus*, Santonian-Maestrichtian) (p. 156)

M. menu (FORBES) [Type species] (Upper Campanian or Maestrichtian of India; comparable forms from Egypt [?] and from Maestrichtian of Saghalien and Hokkaido) (p. 157)

M. japonicus n. sp. (Santonian of Hokkaido and Saghalien) (p. 158)

M. portlocki (SHARPE) (Campanian of Northern Ireland, England and Northern Germany) (p. 163)

M. selbiensis (Pervinquière) (Upper Cretaceous of Tunisia) (p. 166)

M. naibutiensis n. sp. (Santonian of Saghalien) (p. 164)

M. pusillus n. sp. (Santonian of Hokkaido) (p. 165)

M. sturi (REDTENBACHER) (Upper Senonian of Alpine and adjacent areas; a closely allied form from Lower Campanian of Hokkaido) (p. 166)

M. (?) pseudorosalinus (COLLIGNON) (Upper Santonian-Lower Campanian of Madagascar) (p. 157 and p. 172)

Urakawites n. gen.

(Bituberculate forms related to *Eupachydiscus*, Upper Santonian and Campanian) (p. 167)

U. rotalinoides (YABE) [Type species] (Campanian of Southwest Japan, Hokkaido and Saghalien) (p. 169)

U. binodatus (WHITEAVES) (Campanian of Vancouver Island, Canada; a closely allied form from Hokkaido) (p. 172)

U. (?) *macgowani* (HAUGHTON) (Upper Cretaceous of Angola) (p. 168)

U. (?) *auritocostatus* (SCHLÜTER) (Senonian of Northern Germany) (p. 168)

Pseudomenites n. gen.

(Bituberculate forms probably related to *Pachydiscus*, Campanian and Maestrichtian) (p. 169)

P. ambiguus (GROSSOUVRE) [Type species] (Upper Senonian of France, Germany and Tunisia) (?) (p. 168)

P. haldemensis (SCHLÜTER) (Upper Senonian of Northern Germany) (p. 168)

P. (?) n. sp. (?) [= '*Ammonites auritocostatus*' SCHLÜTER, *pars.*] (Upper Senonian of Germany) (p. 168)

P. n. sp. (?) (Upper Senonian of India) (p. 168)

Teshioites n. gen.

(Bituberculate forms derived probably from *Canadoceras* and perhaps in some cases from *Nowakites*, Campanian) (p. 173)

T. ryugasensis n. sp. [Type species] (Campanian of Hokkaido and Saghalien) (p. 174)

T. teshioensis n. sp. (Campanian of Hokkaido) (p. 177)

T. n. sp. (?) [= '*Pachydiscus savini*' GROSSOUVRE, *pars.*] (Upper Cretaceous of France) (p. 174 and 178)

Appendix

A supplemental description of a normal Pachydiscid

Anapachydiscus deccanensis yezoensis MATSUMOTO

1909. *Pachydiscus yezoensis* YABE MS., *nom. nud.*, p. 442, listed only.

1927. *Parapachydiscus* (*Neopachydiscus*) (?) *ezoensis* YABE MS., *nom. nud.*, p. 45 (19), listed only.

1947. *Anapachydiscus yezoensis* (YABE) MATSUMOTO, p. 41, text fig. 1.

Types.— Holotype, GT. I-2742 from Sanushibe, "*Pachydiscus beds*" [= '*Anapachydiscus zone*'], Iburi Province, Hokkaido (H. YABE Coll.). Paratypes, GT. I-2749, immature from the same locality as the holotype (H. YABE Coll.); GT. I-2743, Nino-sawa, Juha-chirinpan, Naibuchi Valley, South Saghalien (M. KAWADA Coll.); GT. I-2744 from loc. N. 360p, zone Mh6; GT. I-2745 from loc. N167p, Mh6 β ; GT. I-2746, loc. N166p, Mh6 β ; GT. I-2747, loc. N141c, Mh6 α ; GT. I-2748, loc. N142h2, Mh6 α ; GK. H2463, loc. N182f, Zone Mh6 β , all in the Naibuchi Valley, South Saghalien (T.M. Coll.).

Diagnosis.— Thickly discoidal shell with fairly narrow and deep umbilicus. Whorls are depressed and inflated throughout life. Suture-lines are similar to those of *Anapachydiscus fascicostatus* (YABE).

Shell in the early immature stage, at diameters below 10mm, is almost smooth and only faintly constricted; in the succeeding stage, at diameters from 10mm. to 25 mm., it is characterized by the *cricki* type of ornamentation, namely, periodic, very short, node-like elevations at the rounded umbilical slope and fine and dense riblets or striae. At diameters from about 30 to 45mm., numerous weak subcostae appear, three or four starting from an umbilical tubercle and three to six intercalated; this ornamentation is the *koluturensis* type.

In the middle stage, at a diameter of about 50mm., the ribs become rather coarse and distant and in the main part of the late growth-stages the whorl is ornamented with distant, large, rounded tubercles on the umbilical border and with radial ribs of moderate strength separated by intervals of moderate breadth. Three or four ribs start from one umbilical tubercle and two or three ribs are intercalated. The ribs show very gentle forward curvature on the flank and at the periphery.

Measurements.—

Specimen	Diameter	Height	Breadth	(B/H)	Umbilicus(%)
GT. I-2742	175	Ca80	104	(1.3)	Ca40 (23)
GT. I-2743	{ 180	75	110	(1.5)	
	{ —	39	53	(1.4)	
for comparison:					
<i>A. deccanensis</i> (STOL. 1865, p.726)	100	51	67.8	(1.3)	21 (21)
<i>A. deccanensis menabensis</i> (COLLICNON, 1952, p.60)	122	67	87	(1.3)	27 (22)
<i>A. subtililobatus</i> (JIMBO) (GT. I-102)	118	58	70	(1.2)	33 (28)
<i>A. arrialoorensis</i> (STOL.) (Examples from Menabe after COLLIC- NON, 1952)	{ 125	52.5	69	(1.3)	33 (24)
	{ 114	53	60	(1.1)	25 (22)
	{ 132	68	72	(1.1)	37 (28)
	{ 128	66	70	(1.1)	28 (22)

Remarks.— Dr. H. YABE (1909) intended to give a new specific name for a specimen of fairly good preservation but has left it unpublished for a long time. Therefore his MS name, *yezoensis* (sometimes listed as *ezoensis*), had been a *nomen nudum* until I gave a concise diagnosis* in a Japanese paper (1947, p. 41). The name *yezoensis* has been valid since that date and emended here as a subspecific name.

Before World War II I observed the original specimen at Tokyo University and found in subsequent collections (including my own) sufficient number of specimens of various growth-ages which are regarded specifically identical with the original. The

* The concise descriptive diagnosis is reproduced here in English translation: *Anapachydiscus yezoensis* has a more depressed whorl than *Anap. sutneri* (YOKOYAMA), thus being rather similar in shell-form to *A. fascicostatus* (YABE). Its ornamentation in the young stage is very similar to that of *A. sutneri*, the *crick* type of ornament appearing early at its diameter of about 10mm. and the *koluturensis* type of ornament at its diameter of about 30mm. Over the diameter of several centimeters the ribs as well as the tubercles become rather suddenly coarse and intense. In fact its ornamentation in the late growth-stage is as a rule coarser and stronger than that of *A. sutneri* in corresponding stage, but there is a certain extent of variation which makes the characters of the two species approaching each other.

diagnosis given above is adopted from my English manuscript prepared at that date. Owing perhaps to some unfortunate accident during or after the war, the specimens seem to be missing at present but the staff of Tokyo University still believes that they may be found. I cannot, therefore, illustrate here the specimens, but the above diagnosis is, I think, useful. If the specimens are confirmed as missing, a neotype would have to be designated.

The present form is closely allied to *Anapachydiscus deccanensis* (STOLICZKA) (1865, p. 126, pl. lxiii, fig. 1) from the Arrialoor group of India and also to *Anapachydiscus deccanensis menabensis* COLLIGNON (1952, p. 60, pl. xviii, fig. 3a, 3b) from the Lower-Middle Campanian of Madagascar, but some minor differences are found. In the regular and relatively slow growth of whorls and in the frequency of tubercles our form approaches the Malgash form, while in the roundness of large tubercles and in the curvature of ribs it is more akin to the Indian form. Thus the three forms under consideration are regarded as subspecifically separated on both the morphological and geographical grounds. Moreover *A. deccanensis yezoensis* is geologically somewhat older than *A. deccanensis* (s.s.) and *A. deccanensis menabensis*, since our Neourakawan is approximately correlated with the Santonian.

The present form resembles *Anapachydiscus fascicostatus* (YABE) (in YABE & SHIMIZU, 1921, p. 57 (5), pl. viii (i), fig. 5; pl. ix (ii), figs. 2a, b, 3, 4, 5) in shell-form, sutures and general construction of the ornamentation, but it is distinguished by the coarser and stronger ornaments. The *koluturensis* type of ornament appears earlier in the former and the distant, large tubercles are characteristic to the *deccanensis* group.

In its tendency to increase the intensity of ornamentation the present form is somewhat allied to such forms as '*Pachydiscus*' *subtililobatus* JIMBO (1894, p. 30 [176], pl. iv [xx], fig. 2, 2a, 2b) and '*Ammonites*' *arrialoorensis* STOLICZKA (1865, p. 126, pl. lxiii, figs. 2, 2a, 3, 3a; pl. lxiv, fig. 1, 1a). In contrast to the rounded and large tubercles of *A. deccanensis* (s.s.) and also of *A. deccanensis yezoensis*, '*P. subtililobatus*' and '*A. arrialoorensis*' have radially elongated and less prominent tubercles. The latter group has somewhat less inflated whorl and still coarser and stronger ribs than the former. In those respects and especially in the development of relatively coarse ribs even in the inner whorls, '*A. arrialoorensis*' STOLICZKA is fairly close to the relatively inflated forms of *Eupachydiscus*, such as *E. teshioensis* (JIMBO). Although *arrialoorensis* was referred to *Anapachydiscus* by COLLIGNON (1952, p. 49) it could be assigned to *Eupachydiscus*; the selection of the alternatives in such a case seems to be a matter of convention. I would suggest therefore calling it for the time being *Anapachydiscus* [*Eupachydiscus*?] *arrialoorensis* (STOLICZKA). As JIMBO's species is based on a single specimen (GT. I-102), whose inner whorl is not well exhibited and whose full-grown body chamber is not preserved, there is some obscurity in determining exactly its systematic position. Provisionally it is called *Anapachydiscus* (?) *subtililobatus* (JIMBO), since it has more numer-

ous and somewhat finer ribs than *A. [E. ?] arrialoorensis* and has finely incised sutures like *Anapachydiscus fascicostatus* (YABE). Summarizing the above, *Anapachydiscus deccanensis deccanensis*, *A. deccanensis yezoensis* and *A. deccanensis menabensis* morphologically show a tendency to give rise to *Eupachydiscus* through such forms as *A. (?) subtililobatus** and *A. [E. ?] arrialoorensis*. However in the present state of knowledge *Eupachydiscus haradai* and *E. teshioensis* appear somewhat earlier than *A. [E. ?] arrialoorensis*, so that more collections are wanted to trace a true phylogenetic lineage.

Occurrence.—Not rare in the Neourakawan of Hokkaido and South Saghalien, approximately Santonian (and also possibly lowest Campanian).

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* The holotype of *A. (?) subtililobatus* (JIMBO) is presumed from its locality and lithic character to be derived from the Paleohetonaian (Campanian).

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The Bituberculate Pachydiscids from Hokkaido and Saghalien

Plates

Plate 31

- Figs. 1-3. *Menuites japonicus* sp. nov.Page 158
1. Lateral (a, b) and apertural (c) views, $\times 1$. Holotype, GT. I-3462 from loc. T 277c, bed IIIId (*Anapachydiscus* zone), Abeshinai Valley, Teshio Province (T. MATSUMOTO Coll.). The body whorl is crushed.
 2. Ventral (a), apertural (b) and two lateral (c, d) views, $\times 1$. Inner whorls of the holotype.
 3. Lateral view (a) and whorl sections (b), showing the well preserved spines, $\times 1$. GT. I-3471 from loc. T956p, bed IIIId, Abeshinai Valley, Teshio Province (T. MATSUMOTO Coll.).

Photos by T. MATSUMOTO & I. OBATA.

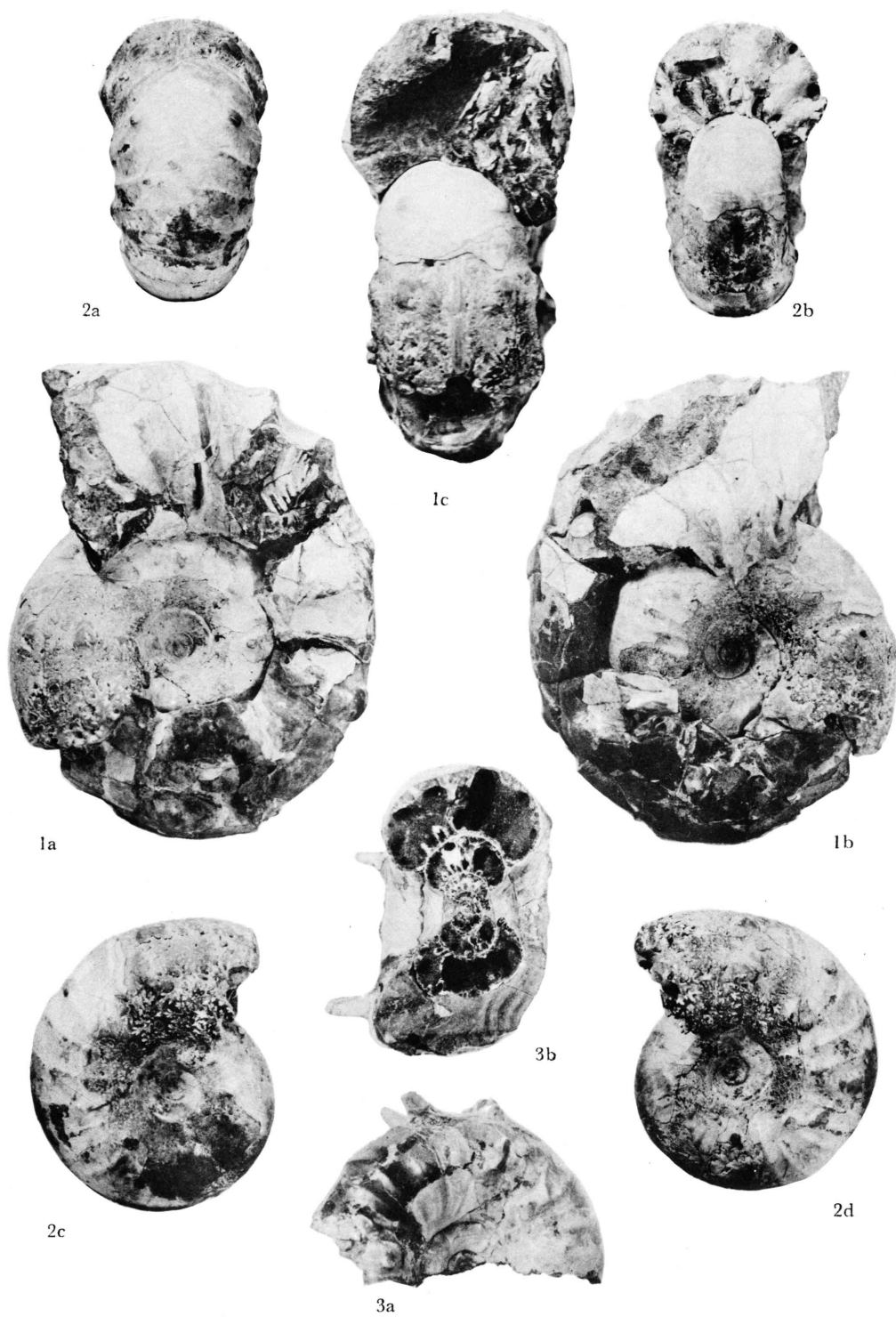


Plate 32

- Figs. 1-4. *Menuites pusillus* sp. nov.Page 165
1. Two lateral (a, b), ventral (c) and apertural (d) views, $\times 5/4$. Holotype, GK. H 3382 from loc. U505, bed Ur1 β (*Anapachydiscus* zone), Urakawa area, Hidaka Province, Hokkaido (T. MATSUMOTO Coll.).
 2. Two lateral (a, b), ventral (c) and apertural (d) views, $\times 5/4$. GK. H 3381 from loc. U506, bed Ur1 β , Urakawa area, Hidaka Province, Hokkaido (T. MATSUMOTO Coll.).
 3. Lateral (a), ventral (b) and apertural (c) views, $\times 5/4$. GT. I-2772 [=Cr 1446] from Urakawa, Hidaka Province, Hokkaido (no further record of collection).
 4. Lateral (a) and ventral (b) views, $\times 5/4$. IGPS. 54436 from a locality along the Sanushibe about 200m. above the confluence of Sakurano-sawa, Iburi Province, Hokkaido (NISHIKAWA Coll.). "*Pachydiscus rotalinoides* YABE" in an old label.
- Fig. 5. *Menuites* aff. *sturi* (REDTENBACHER)Page 166
- Lateral (a) and apertural (b) views, $\times 5/4$. GK. H 3380 from loc. U513, bed Ur2 β' (*Inoceramus orientalis* zone), Urakawa area, Hidaka Province, Hokkaido (T. MATSUMOTO Coll.).
- Fig. 6. *Menuites* cf. *menu* (FORBES)Page 157
- Lateral view, $\times 1$. GT. I-2773 from Onnenai, Hokkaido (no further record of collection).
- Photos by T. MATSUMOTO & I. OBATA.

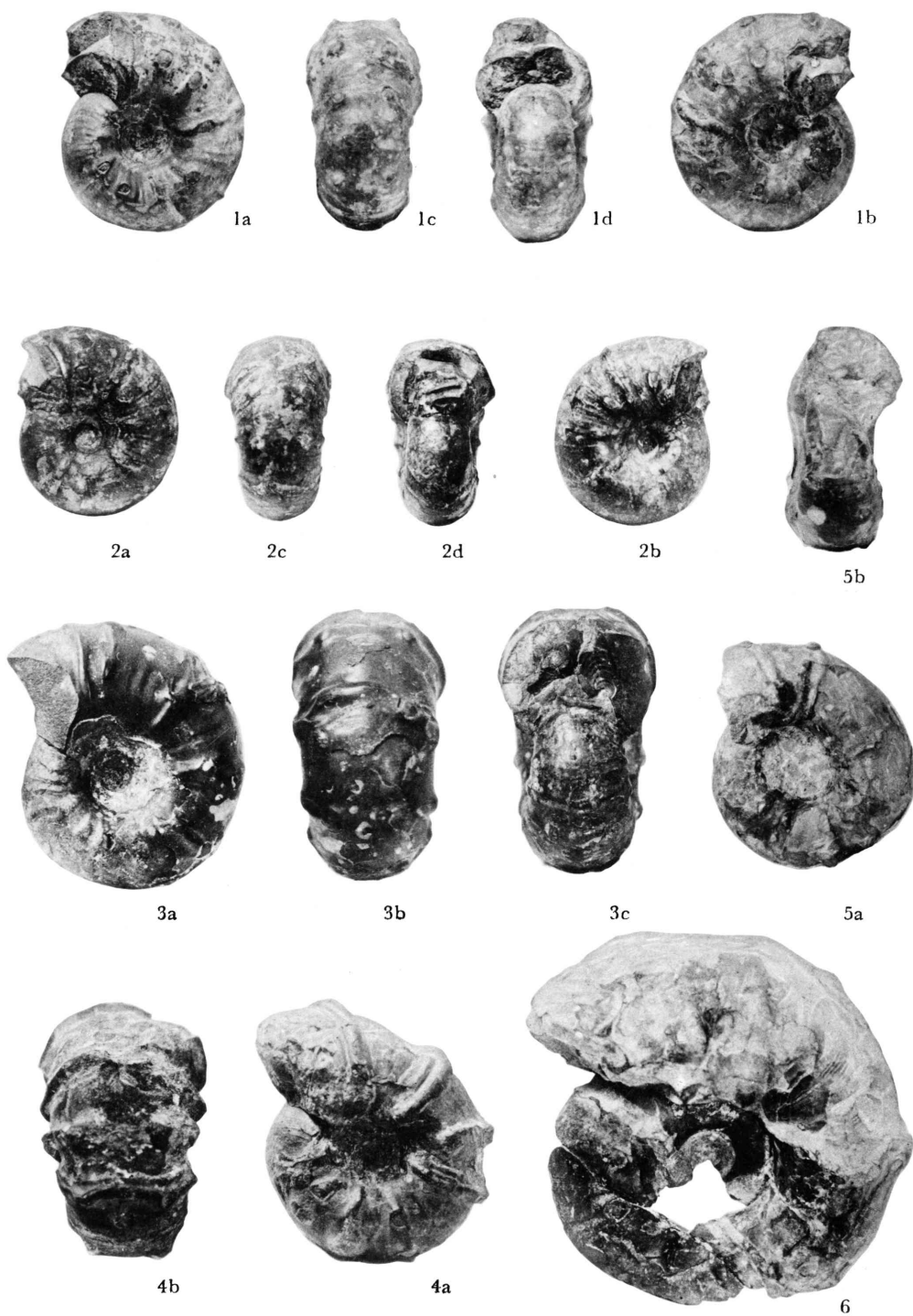


Plate 33

- Fig. 1. *Menuites naibutiensis* sp. nov.Page 164
 Two lateral (a, b), apertural (c) and ventral (d) view, $\times 1$. Holotype, GT. I-524 from Juhachi-rinpan-nino-sawa, a tributary of the Naibuchi, probably derived from the upper part of the Miho group, South Saghalien (M. KAWADA Coll.).
- Figs. 2, 3. *Menuites japonicus* sp. nov.Page 158
 2. Two lateral (a, b), ventral (c) and apertural (d) views, $\times 1$. GT. I-2771 from loc. N446f, zone Mh6 $\alpha \cdot \beta$, Naibuchi Valley, South Saghalien (T. MATSUMOTO Coll.). The body chamber is extremely deformed.
 3. Lateral (a), apertural (b) and ventral (c) views of an immature specimen, $\times 1$. GT. I-536, from the main course of the Naibuchi, South Saghalien (M. KAWADA Coll.).

Photos by C. UEKI (2, 3) and T. MATSUMOTO & I. OBATA (1).

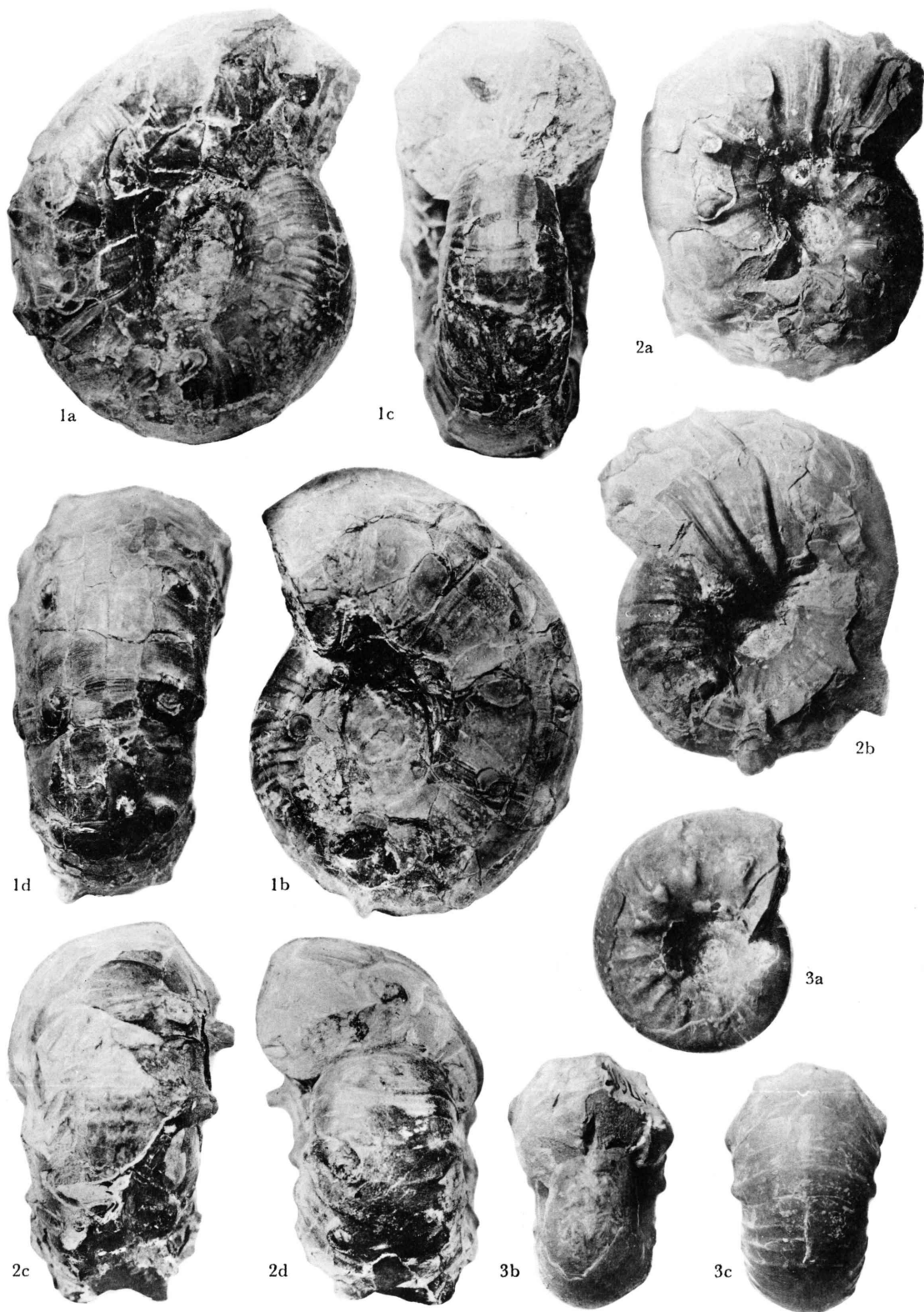


Plate 34

- Figs. 1-3. *Urakawites rotalinoides* (YABE)Page 169
1. Two lateral (a, b) and ventral (c) views, $\times 1$. Lectotype, IGPS. 54438 from Urakawa, "Pachydiscus bed", Hidaka Province, Hokkaido (H. YABE Coll.).
 2. Lateral (a) and ventral (b) views, $\times 1$. GT.I-3469 from loc. T280, bed IIIe (*Inoceramus schmidtii* zone), Abeshinai Valley, Teshio Province, Hokkaido (T. MATSUMOTO Coll.).
 3. Lateral (a) and ventral (b) views, $\times 1$. GT. I-3465 from loc. T 944c, bed IIIe (*Inoceramus schmidtii* zone), Abeshinai Valley, Teshio Province, Hokkaido (T. MATSUMOTO Coll.).

Photos by T. MATSUMOTO & I. OBATA.

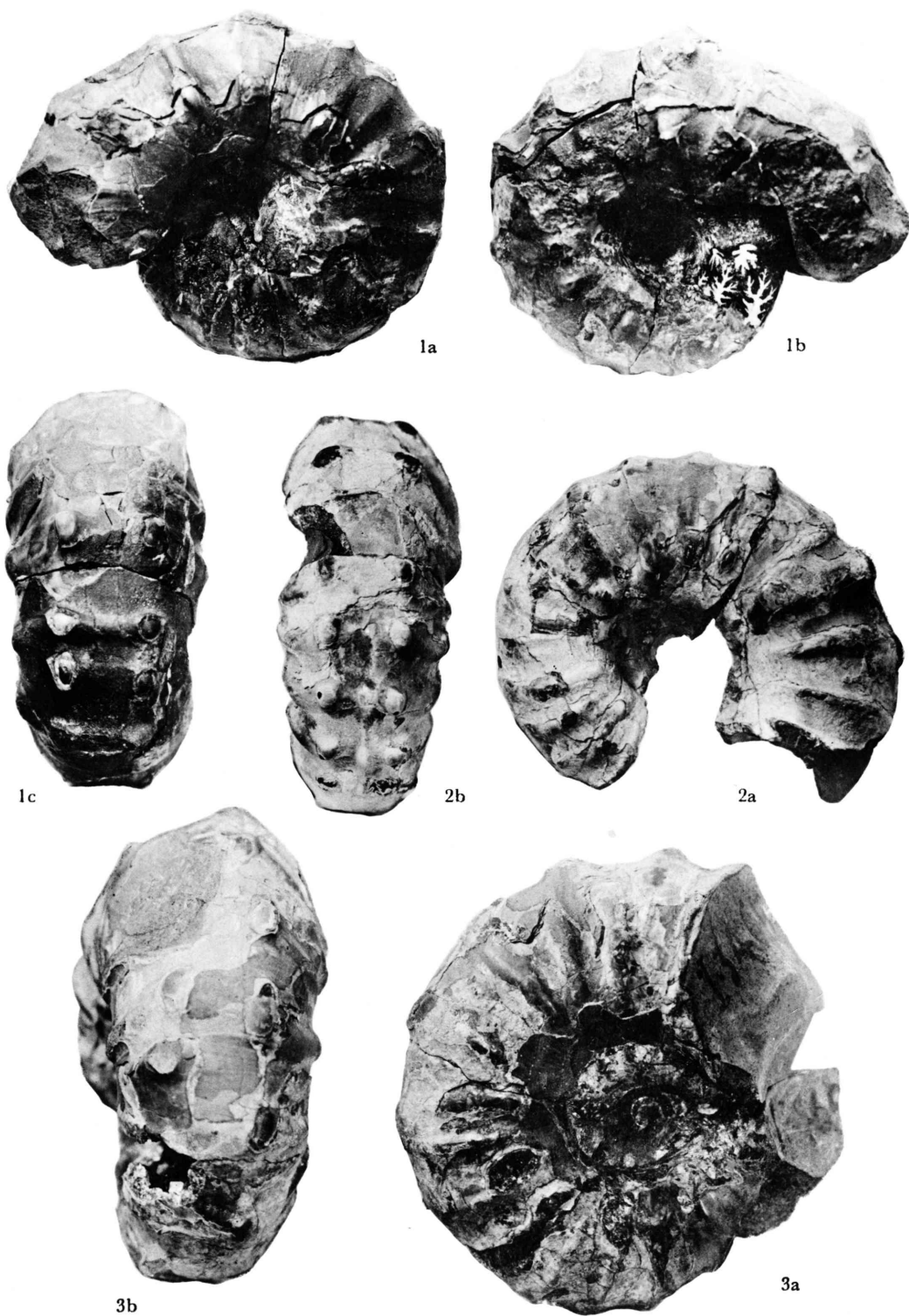


Plate 35

- Fig. 1. *Urakawites* aff. *binodatus* (WHITEAVES)page 172
 Lateral (a) and ventral (b) views, $\times 1$. GK. H 5200, exact locality uncertain in Teshio
 Province, associated with *Inoceramus schmidtii*, Hokkaido (purchased from S. NAGAOKA).
- Fig. 2. *Urakawites rotalinoides* (YABE)Page 169
 Lateral (a, b), ventral (c) and apertural (d) views, of an example of the middle growth-
 stage, $\times 1$. GK. H 3385 from loc. U9, bed Ur4 β (zone of *Inoceramus schmidtii*-*Canadoceras*
kossmati), Urakawa area, Hidaka Province, Hokkaido (T. MATSUMOTO Coll.).
- Fig. 3. *Teshioites teshioensis* sp. nov.Page 177
 Lateral (a, b) and ventral (c) views, $\times 1$. Paratype, GK. H 5212, exact locality uncertain
 in Teshio Province, Hokkaido (purchased from S. NAGAOKA).

Photos by T. MATSUMOTO & I. OBATA.

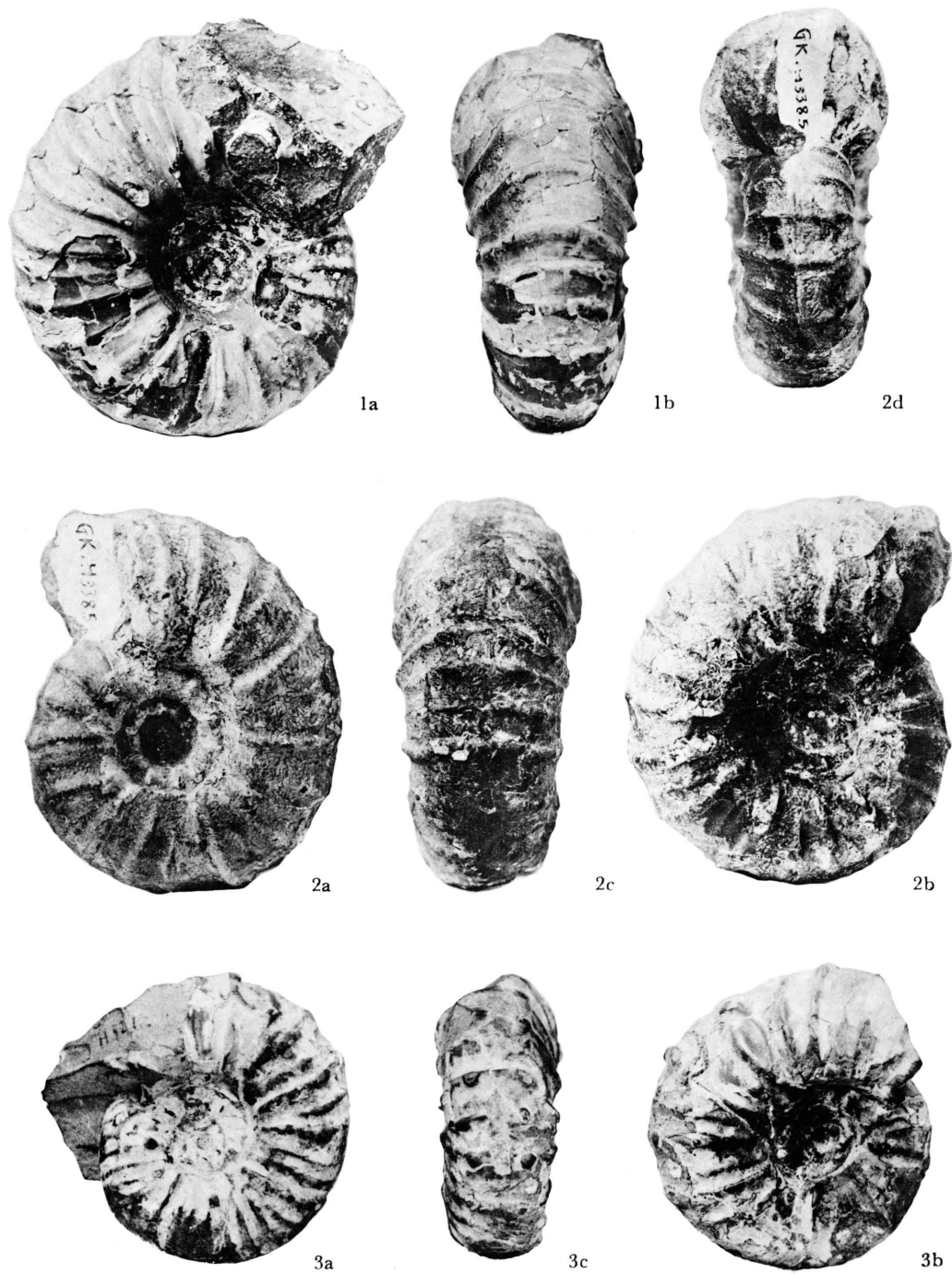
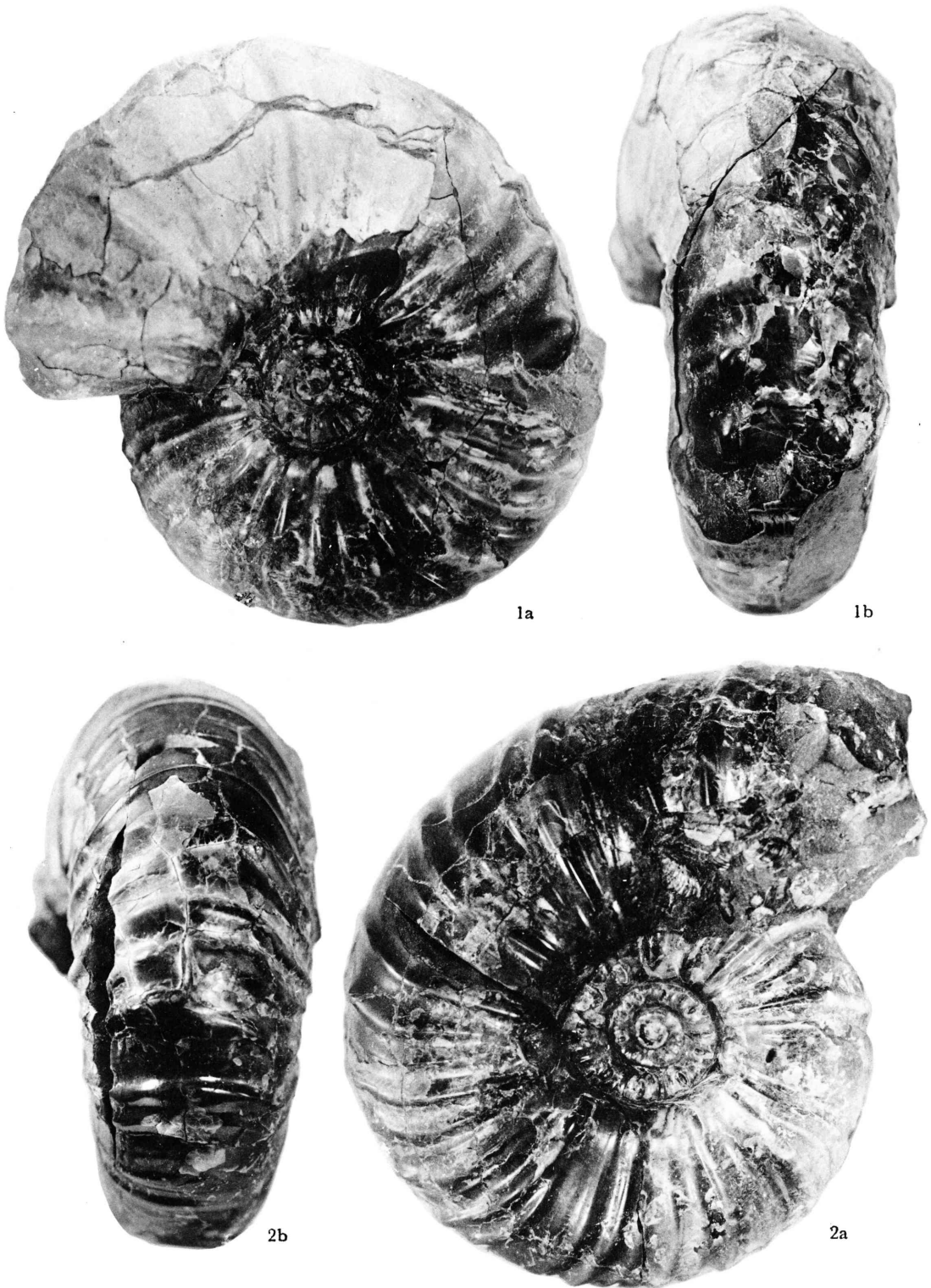


Plate 36

- Figs. 1, 2. *Teshioites ryugasensis* sp. nov.Page 174
1. Lateral (a) and ventral (b) views, $\times 1$. Holotype, GT. I-3488 from loc. T472p, bed IIIe (*Inoceramus schmidtii* zone), Abeshinai Valley, Teshio Province, Hokkaido (T. MATSUMOTO Coll.).
 2. Lateral (a) and ventral (b) views, of an example in which the ventral tubercles are less distinct, $\times 1$. GT. I-3473 from loc. T 731 p2, bed IIIe (*Inoceramus schmidtii* zone), Abeshinai-Saku area, Teshio Province, Hokkaido (T. MATSUMOTO Coll.).

Photos by T. MATSUMOTO & I. OBATA.

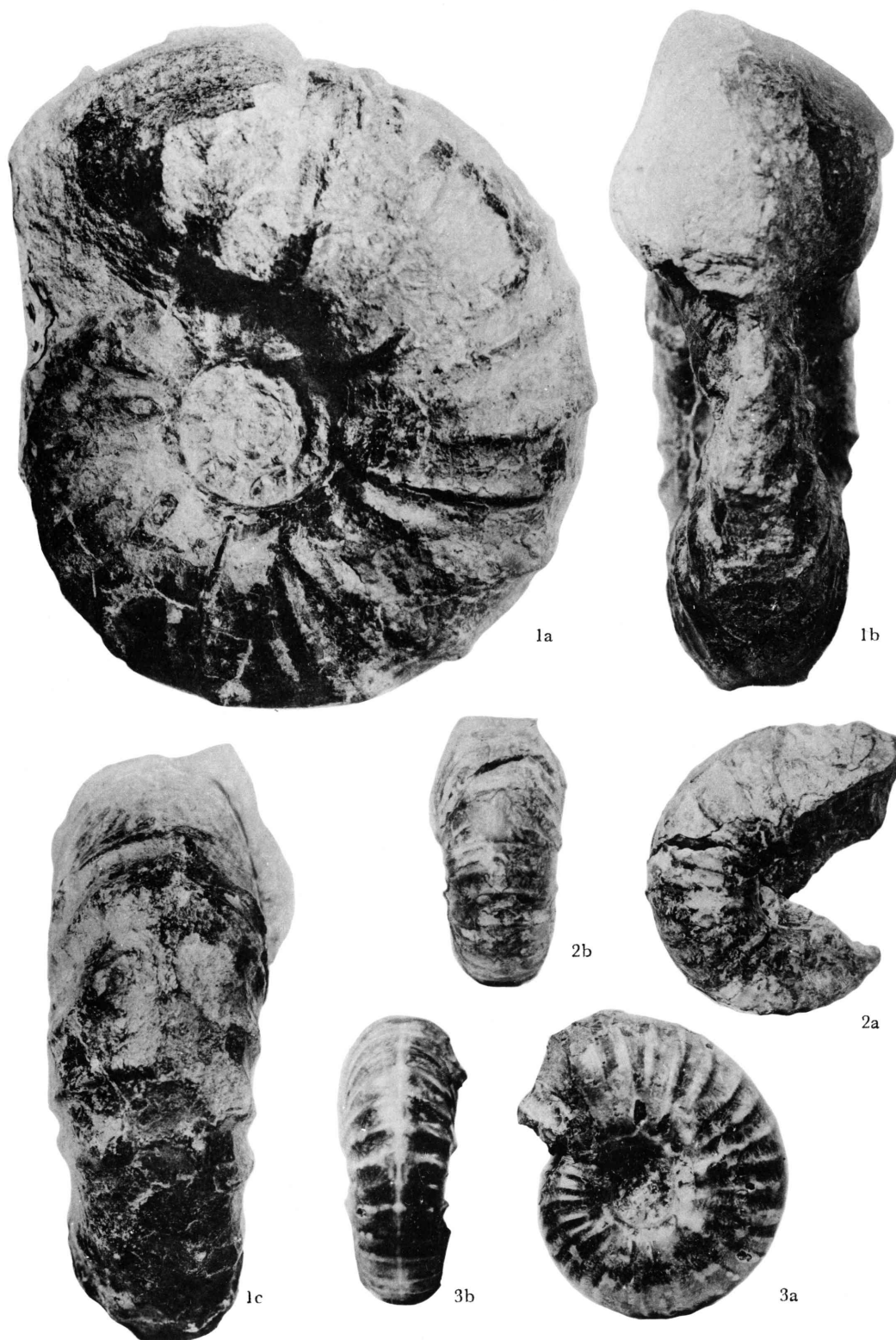


T. MATSUMOTO: Bituberculate Pachydiscids

Plate 37

- Fig. 1. *Urakawites rotalinoides* (YABE)Page 169
 Lateral (a), apertural (b) and ventral (c) views of a probably adult shell, $\times 1$. The shell is somewhat crushed and provided with an ill-preserved aptychus. GT. I-2774 from loc. N428c, bed Ray. (*Inoceramus schmidtii* zone), Naibuchi Valley, South Saghalien (T. MATSUMOTO Coll.).
- Fig. 2. *Teshioites teshioensis* sp. nov.Page 177
 Lateral (a) and ventral (b) views, $\times 1$. Holotype, GT. I-3466 from loc. T908p, bed IIIe (*Inoceramus schmidtii* zone), Abeshinai Valley, Teshio Province, Hokkaido (T. MATSUMOTO Coll.).
- Fig. 3. *Teshioites ryugasensis* sp. nov.Page 174
 Lateral (a) and ventral (b) views of an immature shell, $\times 1$. Paratype, GT. I-3475 from loc. T 472p, bed IIIe, Abeshinai Valley, Teshio Province, Hokkaido (T. MATSUMOTO Coll.). The bituberculate outer whorl is highly crushed and unillustrated.

Photos by T. MATSUMOTO & I. OBATA.



T. MATSUMOTO: Bituberculate Pachydiscids