

Mammites and Allied Ammonites from the Cretaceous of Hokkaido and Saghalien : Studies of Cretaceous Ammonites from Hokkaido and Saghalien-XXXV

Matsumoto, Tatsuro
Kyushu University : Professor Emeritus

Kawashita, Yoshitaro

Fujishima, Yasutaka
Geological Survey, Hokkaido Colliery & Steamship Co.

Miyauchi, Toshiya
Miyauchi Botanical Garden

<https://doi.org/10.5109/1544204>

出版情報 : 九州大学理学部紀要 : Series D, Geology. 24 (1), pp.1-24, 1978-11-10. Faculty of
Science, Kyushu University

バージョン :

権利関係 :



Mammites and Allied Ammonites from the Cretaceous of Hokkaido and Saghalien

(Studies of Cretaceous Ammonites from
Hokkaido and Saghalien-XXXV)

Tatsuro MATSUMOTO*, Yoshitaro KAWASHITA,**
Yasutaka FUJISHIMA,*** and Toshiya MIYAUCHI****

Abstract

Despite world-wide distribution of *Mammites* and allied ammonites, little has been known about their examples from the Cretaceous of Hokkaido and Saghalien. Apart from the well defined *Sumitomoceras faustum* MATSUMOTO and MURAMOTO, 1969, seven species are described in this paper. They are a new species of *Mammites*, two species of *Ampakabites*, two species of *Pseudaspidoceras* and two species of a new genus. Since many of them are based on specimens of independent collections, the descriptions are given in four parts by different authorships. Some species are still poorly known, awaiting more and better preserved specimens. Before the description of the species notes are given on some genera. In conclusion, taxonomic results are summarized and problems of distribution, correlation and evolutionary history are briefly discussed.

Introduction

Mammites is distributed widely in various regions of the world and regarded as an ammonite genus which generally indicates Lower Turonian. Despite its world-wide distribution, little has been known about the representatives of this genus and allied genera in the Cretaceous of Hokkaido and Saghalien.

YABE (1926) proposed the *Mammites* Zone as a lower unit of the subdivisions of his Upper Ammonites Beds and assigned it to the Turonian. It was, however, obscure, because YABE did not designate a particular outcrop as the type section of this zone and gave no palaeontological description of his *Mammites* sp.

The late professor YABE told me, when he was alive, that the specimen of his *Mammites* sp. should be preserved in the University of Tokyo, where I saw only a fragmentary specimen of the Mammitinae from the Opirashibets [=Obira] area of northwestern Hokkaido. This locality is generally in conformity with

* Professor Emeritus, Kyushu University 33, Fukuoka 812..

** 28-6, Tomatsu Tokiwa-machi, Mikasa 068-22.

*** Geological Survey, Hokkaido Colliery & Steamship Co., Yubari 068-04.

**** Miyauchi Botanical Garden, Kusanru, Wakkanai 097.

Manuscript received June 14, 1978.

that of *Mammites* sp. in YABE's earlier report (1909, p. 411).

Later, SHIMIZU (1935, p. 175) listed *Pseudaspidoceras* cfr. *armatum* PERVINQUIÈRE from South Saghalien, without description, whereas *Pseudaspidoceras sorachiense* MATSUMOTO and HASHIMOTO, 1953, was described from Hokkaido. The latter was obtained from a locality outside the mapped area of YABE (1927, text-fig. 2). In 1969 *Sumitonoceras* was established as a genus allied to *Watino-ceras*, with a description of *S. faustum* MATSUMOTO and MURAMOTO, 1969, from the Zone of *Kanabicerias septemseriatum* in the Ikushumbetsu sequence of central Hokkaido (MATSUMOTO et al., 1969).

For years we sought in vain more examples of the Mammitinae until the recent acquisitions, which have been done independently by any one of us. Some of the specimens were at first thought as *incertae sedis*, but the senior author noticed that they belong to the Mammitinae. On this occasion these specimens are assembled altogether, taxonomically sorted and described in this paper.

On account of the above situation the systematic descriptions are subdivided into the following four parts under different subtitles by different authorships:

- Part I Notes on *Mammites* and Allied Genera by T. MATSUMOTO
- Part II Description of *Mammites* from Hokkaido by T. MATSUMOTO and Y. KAWASHITA
- Part III Description of Two Species from Hokkaido tentatively referred to *Ampakabites* by T. MATSUMOTO, Y. FUJISHIMA and T. MIYAUCHI
- Part IV Description of Some Species of *Pseudaspidoceras* and an Allied New Genus from Hokkaido and Saghalien by T. MATSUMOTO

Finally concluding remarks are given by the four authors.

Systematic Descriptions

Part I

Notes on *Mammites* and Allied Genera (T. MATSUMOTO)

There is some difficulty in the taxonomy of the subfamily Mammitinae HYATT, 1900. On this occasion I do not intend to discuss comprehensively the problem, but give some notes on the genera with which the species from Hokkaido and Saghalien may be concerned.

1. Genus *Mammites* LAUBE and BRUDER, 1887

Type-species.—*Ammonites nodosoides* SCHLOTHEIM, 1829

Diagnosis.—Adult shell of moderate to large size and more or less evolute. Whorls thick and typically rectangular to squarish in section, with a flat or slightly concave venter. Ribs as a rule alternately long and short on separate whorls, distant, coarse and predominantly long, with scarcely intercalated shorter ones, on the body-whorl. Long ribs provided with a rounded to bullate tubercle

at or near the umbilical shoulder; every rib with an inner and an outer ventrolateral tubercles, which are more or less clavate. On the outer whorl the outer ventrolateral tubercle may disappear, whereas the inner ones are enlarged to be horn-like; otherwise, the two ventrolateral tubercles are apparently united into a large horn-like tubercle.

Suture of acanthoceratid type, having moderate degree of incisions and squarish general outline of the lateral saddles. L is variable in breadth and in the details of its pattern.

Discussion.—To write the above generic diagnosis I owe much to COBBAN and SCOTT (1972, p. 79–80), WRIGHT (in MOORE (ed.), 1957, p. L 416), REYMENT (1955, p. 49–50) and LAUBE and BRUDER (1887, p. 229), but I have modified to some extent previous descriptions.

The scope of this old established genus is not so definite as has been generally thought. Apart from the too comprehensive concept of LAUBE and BRUDER (1887), the distinction between *Mammites* and *Pseudaspidoceras* is not always clear. *Ammonites conciliatus* STOLICZKA, 1864, for instance, is referred to *Mammites* by some author (e. g., PERVINQUIÈRE, 1907) and to *Pseudaspidoceras* by others (e. g. COLLIGNON, 1965). So I attempt to define *Pseudaspidoceras* in the next section.

2. Genus *Pseudaspidoceras* HYATT, 1903

Type-species.—*Ammonites footeanus* STOLICZKA, 1864

Diagnosis.—Essentially similar to *Mammites* in shell-form, ornamentation and pattern of suture, but is typically characterized by more evolute, flat-sided whorls, a wider umbilicus, comparatively weaker ribs and smaller tubercles than in typical *Mammites*. Another important distinction is that the alternation of long and short ribs disappear at much earlier stage than in *Mammites* and the rectiradiate to slightly rursiradiate major ribs are disposed at longer interval on the main part of the whorls in *Pseudaspidoceras*. Consequently, in *Pseudaspidoceras* there is little or almost no difference in frequency between the umbilical and the ventrolateral tubercles, whereas in *Mammites* the ventrolateral tubercles are more numerous than the umbilical ones, but for a large adult whorl. In *Pseudaspidoceras* several faint, fine ribs or lirae may be discernible on the broad interspace of the major ribs. Some of them may have weak tubercles.

Discussion.—Depending on the above generic diagnosis, I should assign *Ammonites conciliatus* to *Mammites* rather than to *Pseudaspidoceras*. FREUND and RAAB (1969, p. 13) stressed the difference in suture as the most reliable criterion to distinguish *Pseudaspidoceras* from *Mammites*. They thought that the saddles are narrow and L is broad in *Pseudaspidoceras*, but this cannot be maintained as a generic criterion, because the width of the sutural elements is considerably variable in the two genera. COBBAN and SCOTT (1972, text-fig. 38), for instance, has shown that *Mammites nodosoides wingi* (MORROW), from North America, has much broader L and narrower saddles than typical *M. nodosoides*, from central Europe (LAUBE and BRUDER, 1887, p. 230). L is very broad in *M. dixeyi* REYMENT, 1955 (fig. 20) and nearly as broad as the first lateral saddle

in *P. paganum* REYMENT, 1954 (fig. 3h). The complexity of the suture, however, should be taken up as a criterion to distinguish *Pseudaspidoceras* or *Mammites* from *Ampakabites* (see below).

A keel-like elevation on the siphonal line is sometimes discernible in *Pseudaspidoceras* and occasionally so in other genera of the Mammitinae. This was regarded by KOSSMAT (1897, p. 21 [128]) and PERVINQUIÈRE (1907, p. 309) as a variable feature which does not deserve a generic or even specific criterion. The same feature is occasionally observable in some *Acanthoceras* (e. g. *A. amphibolum* MORROW, 1935). FREUND and RAAB (1969, p. 69) regarded this feature as a distinct keel at least in the case of *Ammonites salmuriensis* COURTILLER, 1867, which they transferred from *Pseudaspidoceras* to *Subprionocyclus*. I would not agree them in this generic assignment. It is noted that COLLIGNON (1965, p. 26) referred this species to *Kamerunoceras*.

If the origin of the Mammitinae be ascribed to *Neocardioceras* and *Protacanthoceras* of the Acanthoceratinae, it is not unnatural that a rudimental train of siphonal tubercles or irregular undulations or keel like elevation may occur in some members of the Mammitinae. A rudimentary character is generally variable and occurs irregularly. If a character occurs more constantly, it can be taken up as a generic or specific character. In *Kamerunoceras* REYMENT 1954 (type-species *Acanthoceras eschii* SOLGER, 1904) the siphonal tubercles seem to occur so constantly that it may be better to transfer this genus from Mammitinae to Acanthoceratinae. In response to my inquiry REYMENT has recently written (in lit-1977-12-13) as follows: "*Kamerunoceras* seems to have derived from *Kanabicerias*, at a guess. Many authors confuse it with *Pseudaspidoceras*. There is a certain superficial similarity between these genera, but their ontogenies are quite different."

COLLIGNON (1965) established *Ampakabites* as a subgenus of *Kamerunoceras*, but seems to have recently revised this treatment (see citation in COBBAN and SCOTT, 1972, p. 81).

3. Genus *Ampakabites* COLLIGNON, 1965

Type-species.—*Kamerunoceras* (*Ampakabites*) *auriculatus* [recte *auriculatum*] COLLIGNON, 1965.

Diagnosis.—Shell fairly large, consisting of rapidly enlarging whorls. Septate whorls high rectangular in cross-section, with flat and parallel flanks, low but vertical umbilical walls and a slightly arched venter, ornamented with numerous, rather weak ribs, some of which branched at or near the umbilical tubercle of the long rib; some others may be intercalated; longer ribs provided with bullate umbilical and clavate ventrolateral tubercles. A row of outer lateral tubercles may be added in some species. At the ventrolateral tubercle a weaker rib may form a loop with the major rib. The major ribs, with distinct ventrolateral tubercles, occur at long interval on the septate stage, but the major ribs become frequent on the body-whorl of the adult stage.

Suture much more deeply incised than that of *Pseudaspidoceras*. Lateral

saddles are high and their stems may be narrowed. L has narrow and deep branches. Other lobules are also fairly deep.

Discussion.—I depend on COLLIGNON (1965, p. 29) and COBBAN and SCOTT (1972, p. 81) about the above diagnosis, although I have given some modification.

There is some obscurity in the character of the adult shell, since the hitherto given figures are mainly those of the septate whorls. COLLIGNON (1965, p. 31) described but did not illustrate a large adult example, from which a new species from Japan is considerably different.

4. Genus *Benueites* REYMENT, 1954

Type-species.—*Benueites benueensis* REYMENT, 1954.

Generic diagnosis.—See REYMENT, 1954a, p. 153; 1955, p. 57; WRIGHT, 1957, p. L 416).

Discussion.—This genus was at first (REYMENT, 1954a) set up in the family Collignoniceratidae but later (REYMENT, 1955; WRIGHT, 1957) correctly transferred to Mammitinae, on account of its probable derivation from *Watinoceras*. For the reason of morphological development, *B. benueensis*, a weakly ornamented species, is considered by REYMENT (1955, p. 58) as a derivative from *B. spinosus* REYMENT, which in turn resembles *W. coloradoense* (HENDERSON). These species are all recorded from Lower Turonian but their succession in Nigerian sequences has not yet been clearly shown. BENGTSON (1975, oral com.) reported the presence of *Benueites* in his "middle division" of Turonian in eastern Brazil, which may be upper Lower Turonian in terms of international scale.

Part II

Description of *Mammites* from Hokkaido (T. MATSUMOTO and Y KAWASHITA)

Mammites costatus sp. nov.

Pl. 1, Figs. 1–2; Pl. 2, Figs. 1–2; Text-figs. 1–3

Material.—Holotype is the specimen of Y. KAWASHITA's collection (51-8-20), from a small stream called the Shogakko-no-sawa, in the Oyubari area (Pl. 1, Fig. 1; Pl. 2, Fig. 1; Text-fig. 1). Paratypes: two other specimens of Y. KAWASHITA's collection (5-11-14 and 51-8-8) from the Oyubari area; another specimen of Takemi TAKAHASHI's collection and G. H5868 (T. MATSUMOTO's coll.) from the Obira [=Opirashibets] area.

Specific diagnosis.—Large ammonite, about or somewhat over 300 mm in diameter at the last stage. Evolute whorls, subquadrate in section, with fairly distant, coarse ribs, which are counted about 15 to 18 in the last entire whorl, of which several are intercalated shorter ones. On the last part of the whorl, for about 45° or so near the apertural margin, the ribs tend to be less distant and narrower than on the main part. The long rib may be somewhat elevated to a bulla at the umbilical shoulder but the bullae become obsolete at the late

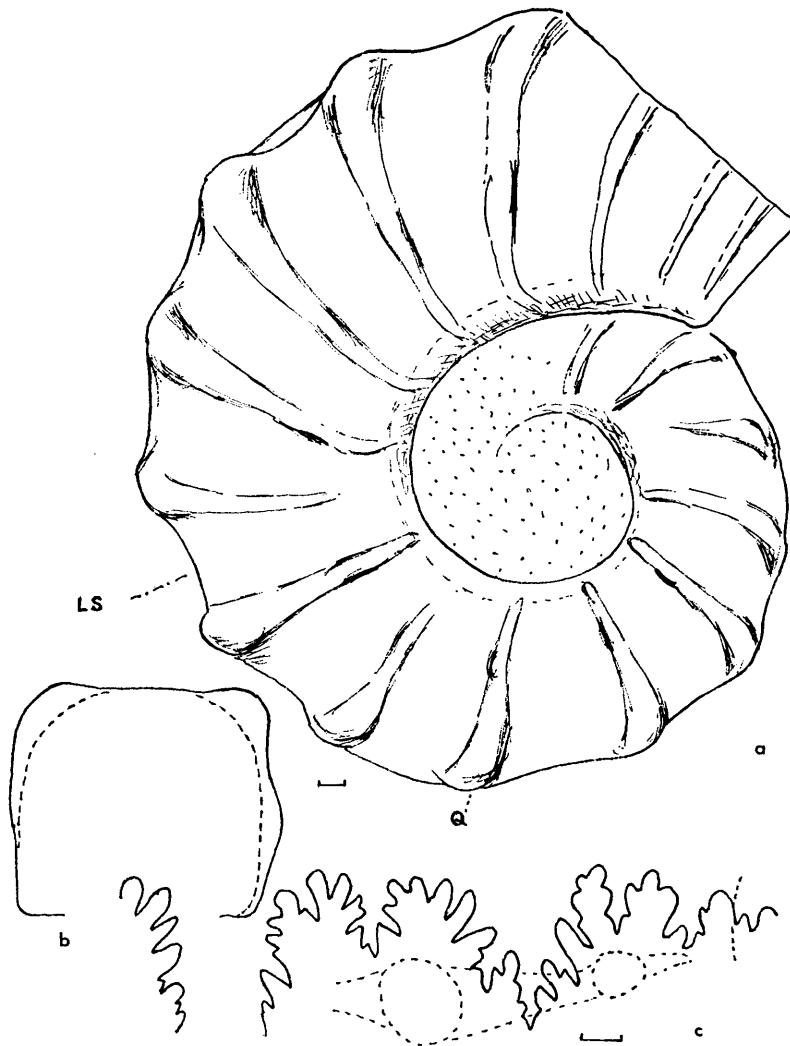


Fig. 1. *Mammites costatus* MATSUMOTO and KAWASHITA, n. sp.

Diagrammatic sketch of the holotype. Lateral view (a), showing the position of the last septum by LS; whorl-section (b) at Q and external suture (c) at about Q. Bar shows 10 mm. (T. MATSUMOTO *delin.*)

stage, when stronger, more rounded nodes occur on the long ribs at some distance from the umbilical shoulder. The bullae finally disappear on the last part. Double ventrolateral tubercles united into a thick, strong node on every rib of the last whorl, but the node tends to be weakened on the last part. Suture moderately incised, characterized by broad, massive first lateral saddle, widely opened and apparently tripartite L and much smaller U2.

Description.—The holotype is at least 320 mm in diameter and there is still an incompletely preserved last part. The entire diameter would be about 360 mm, if completely preserved. The last septum is at about 240 mm in diameter

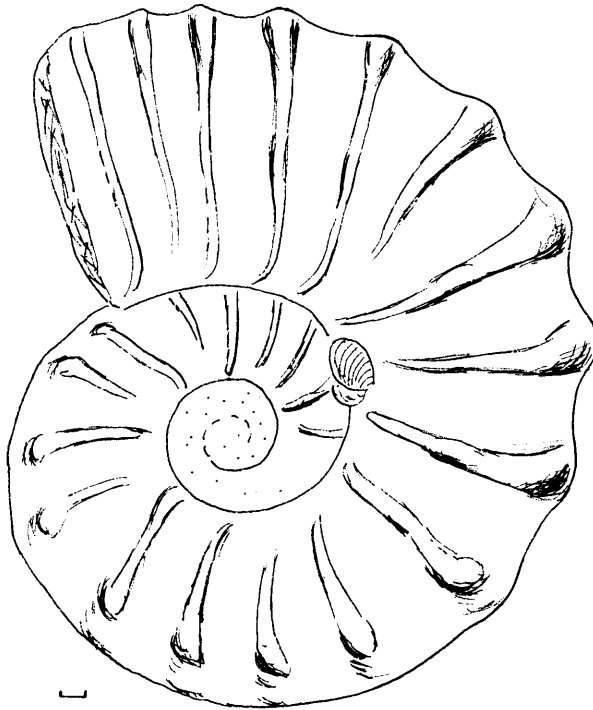


Fig. 2. *Mammites costatus* MATSUMOTO and KAWASHITA, n. sp.
Diagrammatic sketch of the paratype no. 1. Bar shows 10 mm.
(T. MATSUMOTO delin.)

and the preserved part of the body-chamber is slightly less than a half whorl (160°). On this body-whorl there are 7 (+1?) ribs, of which the first one is shorter and the last 2 (+1?) are weaker and narrower than the rest. The tubercles are as described above.

On the last half of the septate whorl there are 7 ribs, of which two are shorter. As shown in Text-fig. 1b, a short rib on one side continues to a long one on the other side, but this is not a specific character, because such a feature is not seen in the paratypes. The suture at this stage is well shown (see Pl. 2 Fig. 1 and Text-fig. 1c).

The ornamentation of the immature stage is not well shown in this holotype.

The paratype figured (Pl. 1, Fig. 2; Pl. 2, Fig. 2) (Text-fig. 2) is about 290 mm in diameter and there is a detached fragment of the presumably last portion. The last septum is at 200 mm in diameter and the undestroyed main part of the body-chamber is slightly less than a half whorl (about 170°). On this body-whorl there are 9 ribs, of which 2 are somewhat shorter than the rest. The ribs on its main part are coarse and distant but they become to be gradually narrower, weaker and less distant in the last part ($40-50^\circ$).

On the last half of the septate whorl there are 8 distant ribs, of which 3 are shorter than others. In the preceding part a similar ribbing is observable for a while, but the ornamentation of still younger stage is not well exposed.

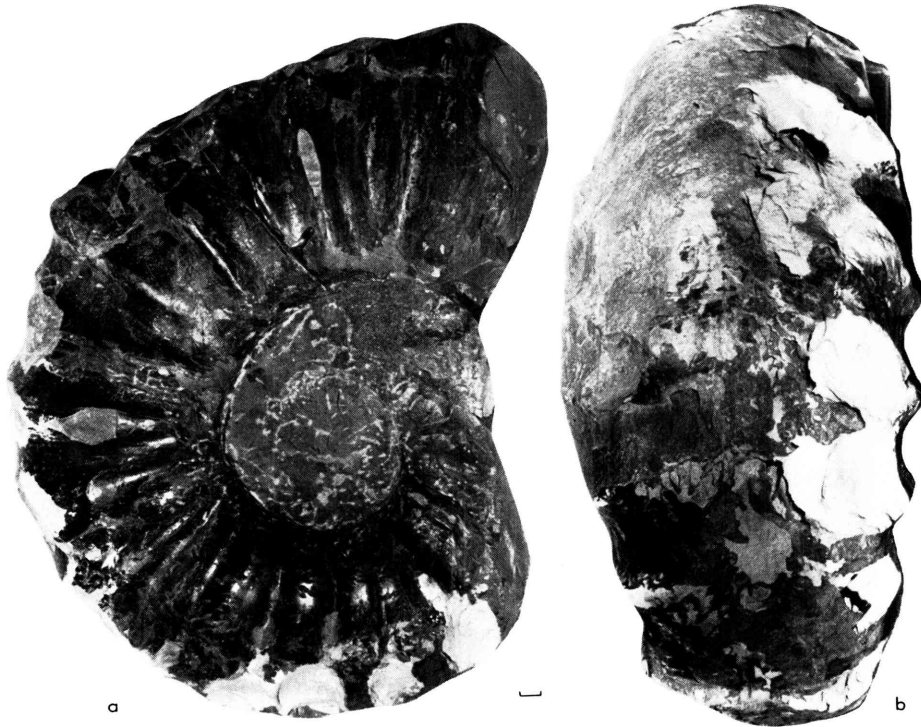


Fig. 3. *Mammites costatus* MATSUMOTO and KAWASHITA, n. sp.

Paratype no. 2. Lateral (left) and ventral (right) views. Bar shows 10 mm.
(Photos by Y. KAWASHITA, without whitening)

The tubercles at the umbilical shoulder are variably thick on the septate whorl but disappear or remain as indistinct bullae on the body-whorl. The long ribs on the body-whorl and the preceding last part of the septate whorl have stronger tubercles at an inner lateral point. They are at first thick and nodose but narrowed and bullate in the late part, where ribs are also narrowed, and finally become obsolete.

The double ventrolateral tubercles are united into a thick node on every rib of the outer whorl, except on the last part where the node becomes less thick and tends to be weakened.

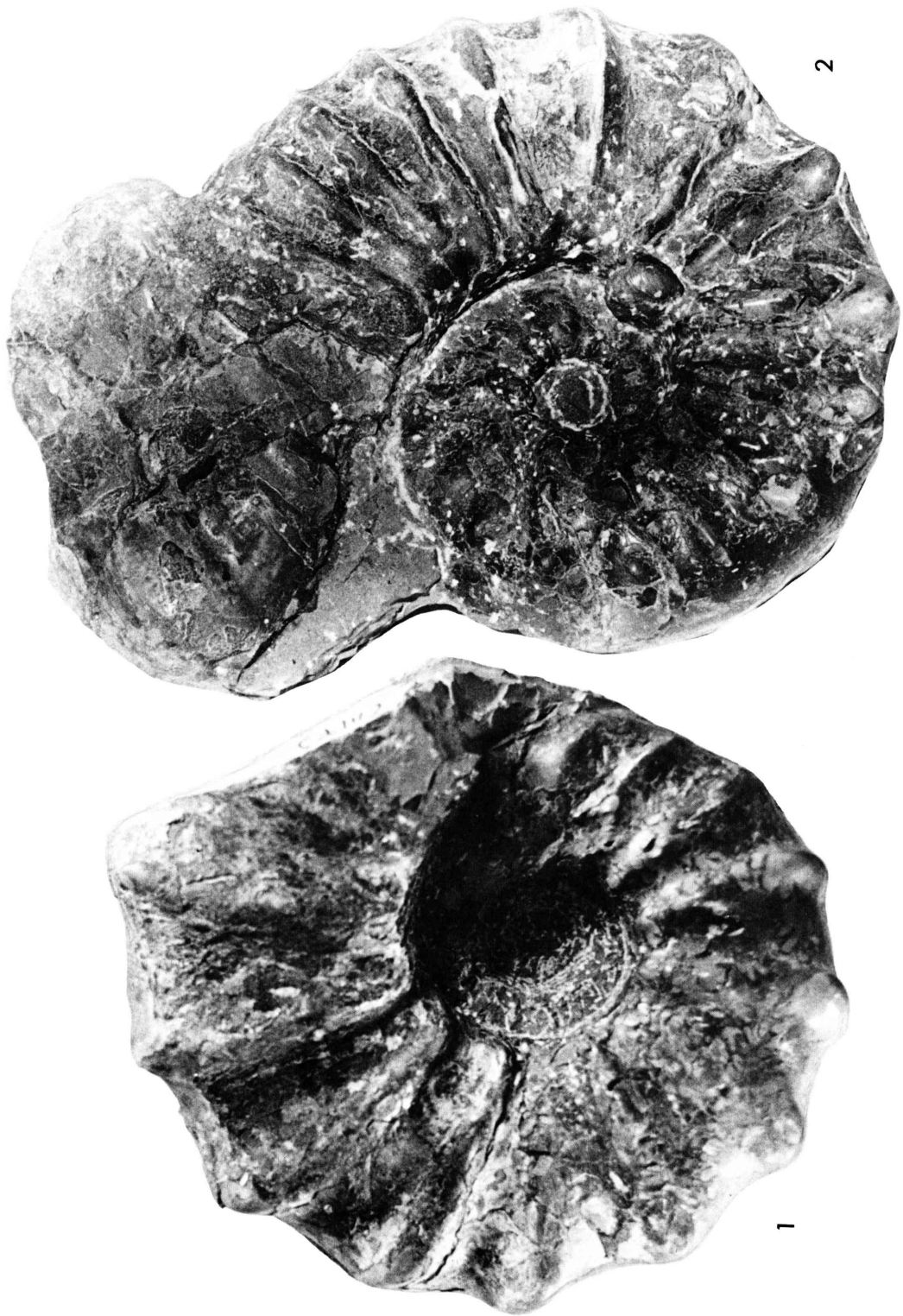
The third specimen in KAWASHITA's collection (Text-fig. 3) and the fourth in TAKAHASHI's collection are likewise large and have more numerous ribs with

Explanation of Plate 1

Figs. 1-2. *Mammites costatus* MATSUMOTO and KAWASHITA, n. sp.Page 5

1. Holotype, KAWASHITA's Coll. 51-8-20, from the Oyubari area. Lateral view, $\times 1/3$.
2. Paratype 1, KAWASHITA's Coll. 51-11-14, from the Oyubari area. Lateral view, $\times 2/5$.

Y. KAWASHITA photos, without whitening.





less numerous shorter ribs. The fourth specimen is unusual in having tubercles at both the umbilical shoulder and at an inner lateral point for a considerable interval of the outer whorl. The united ventrolateral nodes in this specimen are as thick as in others.

Measurements (in mm).—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
Holotype	318.0	94.5(0.30)	130.0(0.41)	—	—
"(−180°) (ic)	—	—	94.0	102.0	1.09
Paratype 1	278.0	85.0(0.30)	113.0(0.41)	—	—
"(−180°) (c)	—	—	80.0	94.5	1.17

(ic): intercostal, (c): costal

Comparison.—This species resembles *Mammites nodosoides* (SCHLOTHEIM) in the large size, subquadrate whorls, general characters of ornamentation and in suture. *M. nodosoides* is an old established species and known from the Lower Turonian of various regions of the world, but its true extent of variation has not been precisely described. As we had little opportunity to look at the actual specimens from Europe, Africa, central and southwestern Asia and South America, we have to depend on described examples. COBBAN and SCOTT (1972, p. 78–79) have recently given concise remarks on them and regarded the specimens from the Western Interior province of North America as representing a geographical subspecies, *M. nodosoides wingi* MORROW, 1935. Whether other names proposed as varieties or subspecies could remain as valid geographical subspecies or not was not clearly stated by COBBAN and SCOTT. The form called *M. nodosoides* var. *afra* PERVINQUIÈRE (1907) was regarded by FREUND and RAAB (1969, p. 12) as a mere variant and does not seem to constitute a geographical subspecies. I do not know whether *Mammites nodosoides chivensis* ARKHANGUELSKY (1916) can truly represent a subspecies of central Asia.

Even if we consider such variability of *M. nodosoides* as represented by a number of varietal or subspecific names, we conclude that the available specimens from Hokkaido probably represent a distinct species which is outside that wide variation. The main difference is in that our species has more numerous ribs on the adult whorl, on which several are still shorter and intercalatory and the ribs become less distant, weaker and provided with weakened or obsolete tubercles at the last stage (of about a quarter whorl). The apparently tripartite L may be another criterion of our species, but the suture is essentially similar to that of *M. nodosoides chivensis*, from central Asia, illustrated by ARKHANGUELSKY

Explanation of Plate 2

Figs. 1–2. *Mammites costatus* MATSUMOTO and KAWASHITA, n. sp. . . . Page 5

1. Holotype, KAWASHITA's Coll. 51-8-20, from the Oyubari area. Ventral view, $\times 1/2$.
2. Paratype 1, KAWASHITA's Coll. 51-11-14, from the Oyubari area. Central view, $\times 2/3$.

Y. KAWASHITA photos, without whitening.

(1916, text-fig. 18). In our species the outer ventrolateral tubercles do not persist for so long time as in *M. nodosoides* and united ventrolateral protuberances characterise the outer whorl. Our specimens do not show so much projected horns as typical examples of *M. nodosoides*. Thickly rounded umbilical tubercles are not developed in the observable part of the whorls in our species, although we do not know the characters of its immature stage. The umbilical tubercles, however, are sometimes bullate even in *M. nodosoides*, as described by PERVINQUÈRE (1907) and FREUND and RAAB (1969). The apparent multituberculate state resulted from the transition of tubercles at a middle growth-stage from the umbilical shoulder to an inner lateral point is peculiar to the present species, but the coexistence of the two kinds of tubercles on the same rib does not normally persist for a long time, except for an unusual example in TAKAHASHI's collection.

To sum up, we conclude that the present species is closely allied to but distinguished from *Mammites nodosoides*. It should be noted that our specimens occurred in muddy sediments of somewhat off-shore and presumably deeper facies, whereas examples of *M. nodosoides* have mostly been reported from the epicontinental deposits of shallower facies. It is also noted that the available specimens of the present species are all large and probably adult. No immature specimens have been found together with them. In other words some difference in habitat between *M. nodosoides* and *M. costatus* is suggested from both the morphological characters and the mode of occurrence.

The present species is somewhat similar to *Mammites daviesi* SPATH (1935, p. 415, text-fig. 1; pl. 32), from Ramri Island, Burma, in the coarse ribbing and not much conspicuous ventrolateral tubercles, but the latter has persisting outer ventrolateral tubercles, accordingly an octagonal, rather than quadrate, whorl-section and much broader L and narrower lateral saddles.

Mammites mocamedensis HOWARTH (1966, p. 6, pl. 3), from Angola, likewise has moderately strong ribs, but its venter is more rounded and, accordingly, the intercostal whorl-section is subcircular. In this species the outer ventrolateral tubercles persist. What was called the extra upper ventrolateral tubercles by HOWARTH may imply the presence of intercalatory short ribs remaining on the outer ventrolateral part. Anyhow, our species is distinct from that Angola species in these characters.

Occurrence.—The holotype and the second paratype (Y.K. 51.8.8) came from a small stream, called the Shogako-no-sawa, near Kashima, Oyubari district. The Zone of *Inoceramus* aff. *saxonicus* is exposed in the upper reaches of this stream, where the paratype was obtained in situ. The holotype was probably derived from the same zone. The first paratype (Y.K. 51.8.20) was found in situ at loc. Y 5201 from the Zone of *Inoceramus* aff. *saxonicus*, on the right bank of the Hakkin-zawa (a tributary of the Shiyubari), in the same Oyubari district. The third paratype (T.T. coll.) is from the Sato-no-sawa of the Obira area, derived probably from Member Mj. Another comparable specimen (GK. H5868) is from loc. R2307, 82-Rinpan, Naka-Kinembetsu (Obira area), from the mudstone of Member Mj.

Part III

Description of Two Species from Hokkaido
tentatively referred to *Ampakabites*

(T. MATSUMOTO, Y. FUJISHIMA and T. MIYAUCHI)

Ampakabites regina sp. nov.

Pl. 3, Fig. 1; Pl. 4, Fig. 1; Pl. 5, Fig. 2; Text-figs. 4, 5

Material.—Holotype, HCS. No. 92, collection (72-8-10) of Y. FUJISHIMA, from an exposure at 10 km point along the Panke-moyuparo [=Shimo-yubari], a tributary of the Yubari in the Oyubari area. Paratype (septate whorl), No 28c of T. MIYAUCHI's collection from the northwestern end of the Chiyenaibo, eastern side of Soya peninsula in northern Hokkaido.

Specific diagnosis.—Large ammonite whose characters remarkably change from the septate whorl to the adult body-whorl. Whorl grows fairly rapidly in height, with a little overlap. Umbilicus of moderate size (32 percent of the entire shell diameter) in the adult holotype, but somewhat narrower (28%) in the septate paratype.

Septate whorls higher than broad, with parallel and flat flanks, subrounded ventrolateral shoulders, a slightly arched venter, angular umbilical shoulders and low but vertical or overhanging umbilical walls. The ornamentation on the septate whorl generally weak, except for the bullate umbilical tubercles which may be considerably raised or pointed at the umbilical shoulder. In the holotype there are 11 umbilical tubercles per half whorl. Numerous ribs rather irregular in length, intensity and details of curvature. Longer ribs normally provided with a bullate umbilical tubercle and a clavate ventrolateral tubercle. Some of them are periodically more distinct than others and accompanied with faint constrictions. Accordingly the ventrolateral clavae consist of periodic distinct ones and extremely weak ones. There are some intercalatory or branched weaker ribs. In addition to them fine lirae may be discernible on the test. Two or more ribs are looped at the ventrolateral clavi. The ribs are rursiradiate on the umbilical wall, somewhat concave near the umbilical shoulder, slightly prorsiradiate or gently flexiradiate on the main part of the flank, and curved considerably forward on the venter.

The body-chamber occupies slightly more than a half whorl. It is somewhat higher than broad and roughly ellipsoid in cross-section, having a moderately arched venter, gently inflated flanks, subrounded umbilical shoulders and nearly vertical, moderately high umbilical walls. It is ornamented with strong and coarse radial ribs, which are mostly long, separated by somewhat broader interspaces, nearly rectiradiate or gently concave, on the flank and show a gently forward curvature on the venter, where the ribs are lowered and broadened. There are 13 ribs on the body-whorl of the holotype, of which only one at the beginning is shorter than others. The umbilical tubercles at first sharply pointed at the umbilical shoulder, but on the main part less prominent. At the ventro-

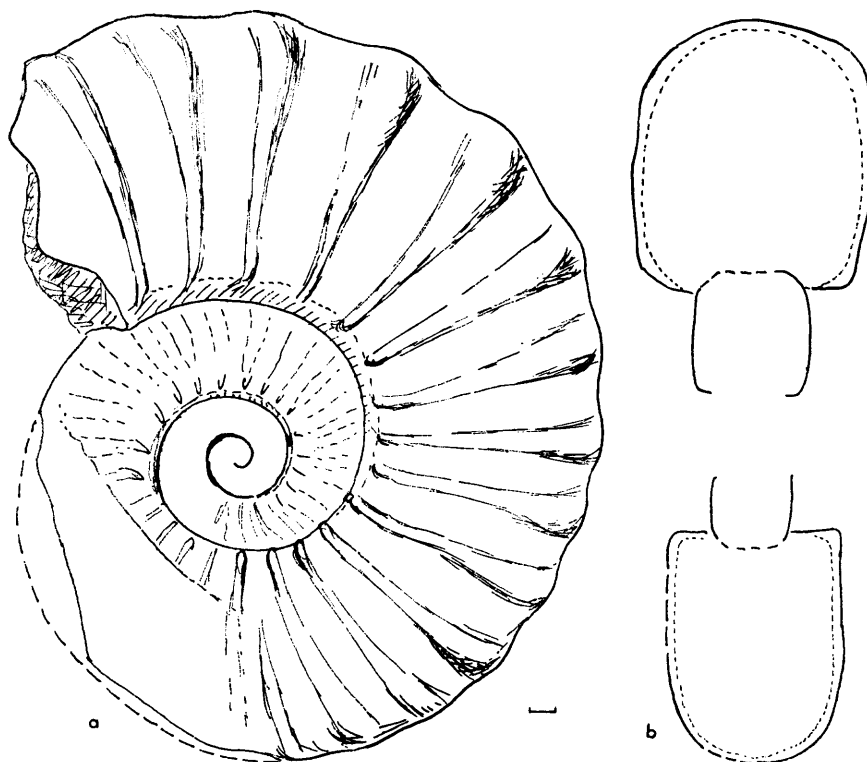


Fig. 4. *Ampakabites regina* MATSUMOTO, FUJISHIMA and MIYAUCHI, n. sp.
Diagrammatic sketch of the holotype. Lateral view (left) and whorl-section
(right). Bar shows 10 mm. (T. MATSUMOTO *delin.*)

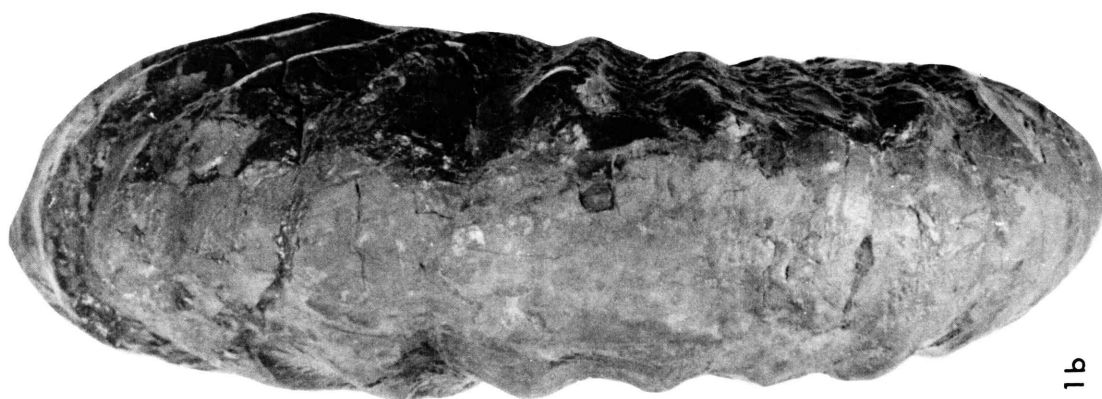
lateral shoulder ribs are thickened and somewhat elevated, without forming distinct nodes. Some of the ribs may be slightly elevated at an inner lateral point but never form a distinct tubercle.

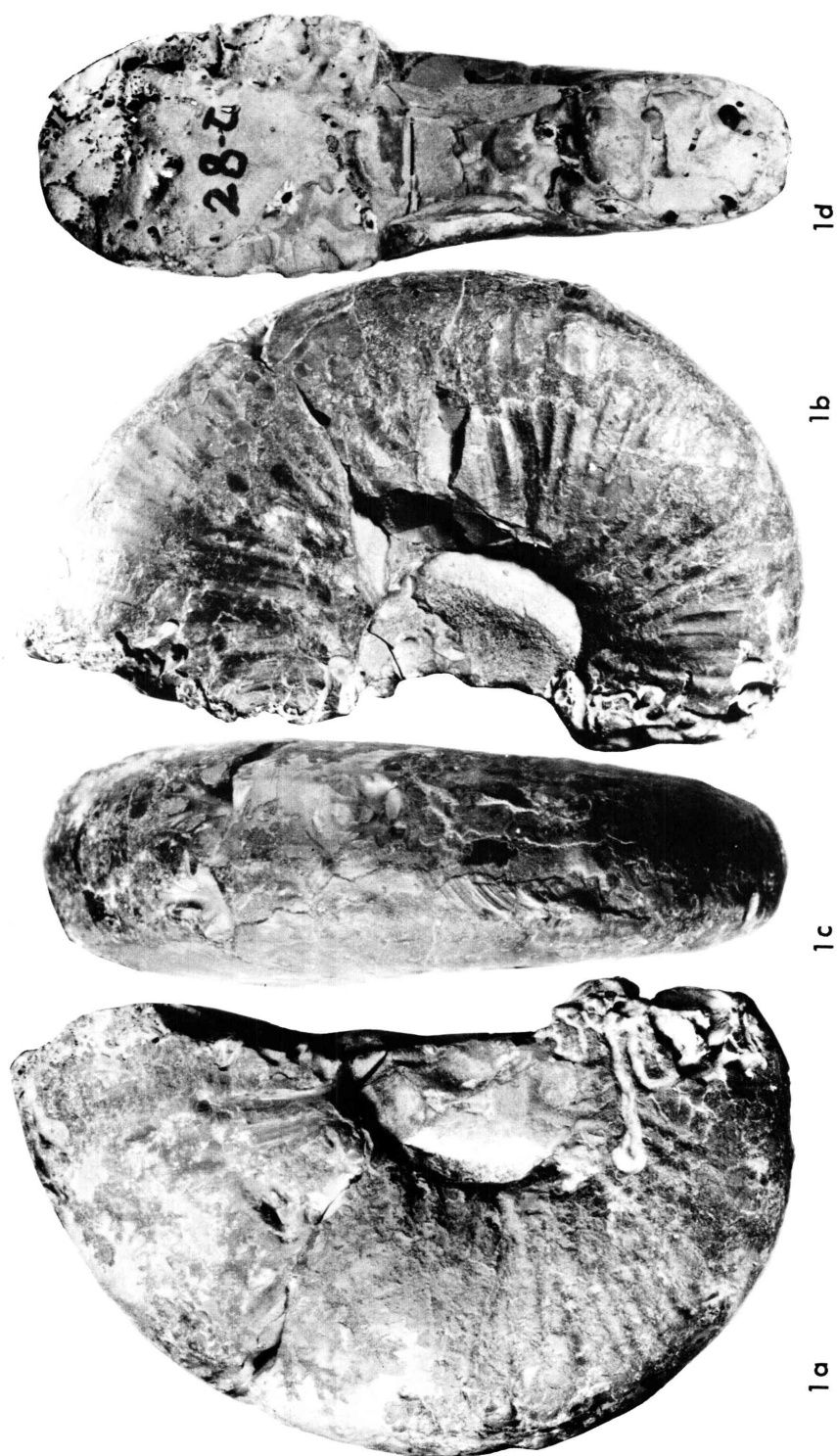
Suture deeply incised, having narrow and long branches of L, fairly tall lateral saddles and smaller U2. Subdivided folioles show somewhat phylloid terminals.

Remarks.—The holotype is a magnificent specimen of about 300 mm in diameter. The last part of its septate whorl is somewhat water-worn on one side and on the venter; otherwise the specific diagnosis is well shown by this holotype. The deficiency of the holotype is well supplemented by the paratype. In this paratype a narrow zone along the siphonal line is slightly elevated, if not

Explanation of Plate 3

- Fig. 1. *Ampakabites regina* MATSUMOTO, FUJISHIMA and MIYAUCHI, n. sp. ...
.....Page 11
Holotype, HCS. No. 92, Y. FUJISHIMA's Coll. 72-8-10, from the Panke-
moyubari, Oyubari area. Lateral (a) and ventral (b) views, $\times 1/2$.
Kyushu Univ. (K. TANABE) photos, without whitening.





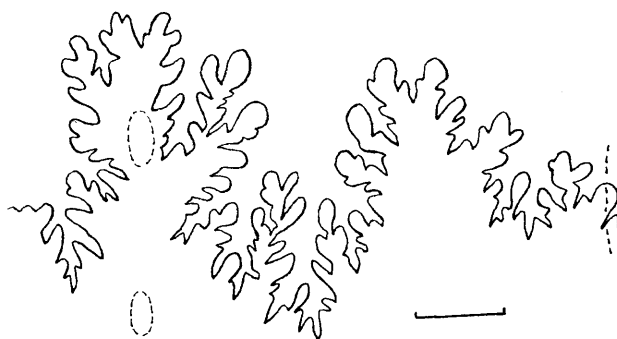


Fig. 5. *Ampakabites regina* MATSUMOTO, FUJISHIMA and MIYAUCHI, n. sp.
External suture of the paratype at whorl-height=60 mm.

(T. MATSUMOTO delin.)

forming a distinct keel, and the zones on either side of it on the venter are somewhat flattened. As a whole the venter is gently arched.

There is another fragmentary specimen in T. MURAMOTO's collection (Obs-R1), from the Obira area. This may be comparable with the inner whorl of the present species but the observable ribs are more regular. Therefore we hesitate to conclude the specific identity, although it is probably an example of *Ampakabites*.

Measurements (in mm).—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
Holotype (−10°)	292.0(1)	95.0(0.32)	115.0(0.39)	~92.5(0.31)	0.80
„ (−190°)	—	52.0	88.0	67.0	0.76
Paratype	141.0(1)	39.4(0.28)	65.5(0.46)	47.7(0.43)	0.73

Comparison.—The septate whorl of the present species is somewhat similar to that of *Ampakabites auriculatus* (COLLIGNON, 1965), from the *Mammites conciliatus* Zone of Madagascar, in the shell-form, weak ribbing, distant ventrolateral clavae and deeply incised sutures, but the former has more numerous and weaker ribs and weaker ventrolateral clavae. A large adult whorl of *A. auriculatus* is said to have frequent and weak ribs, but that of our species has much coarser, stronger and moderately distant ribs.

Ampakabites collignoni COBBAN and SCOTT, 1972, from the Bridge Creek Limestone Member of Colorado (North America), is somewhat similar to our

Explanation of Plate 4

- Fig. 1. *Ampakabites regina* MATSUMOTO, FUJISHIMA and MIYAUCHI, n. sp. ...
.....Page 11
Paratype, T. MIYAUCHI Coll. No. 28c, from Chiyenaibo, eastern side of
Soya peninsula. Two lateral (a, b), ventral (c) and natural sectional
(d) views of a septate whorl, $\times 2/3$.

Kyushu Univ. (K. TANABE) photos, without whitening.

species. It has more numerous ribs than *A. auriculatus* but less so than our species. The ventrolateral tubercles are double in that species but single in *A. auriculatus* and the present species. Ribs are characteristically looped at the ventrolateral tubercles in the three species, but the mode of looping in our species is not so regular as in *A. collignoni*. COBBAN and SCOTT (1972, p. 82) describe that the ribbing becomes irregular and somewhat flexuous on the body-whorl of *A. collignoni*, although the body-whorl seems to be incompletely preserved in the holotype. Anyhow, the strong and regular ribbing on the adult body-whorl is characteristic of the present species.

It should be noted that the septate whorl of the present species is fairly similar to *Benueites benueensis* REYMENT, 1954, from the Lower Turonian of Nigeria, in shell-form and ornamentation, but that species is described to have a sulcus on the arched venter (REYMENT, 1954a, p. 153). The remarkable distinction is that the present species has deeply incised, fairly complex sutures.

To sum up, we refer the present species tentatively to *Ampakabites*, until the scope of *Ampakabites* or that of *Benueites* becomes clearer. This species seems to suggest the close affinity of *Ampakabites* with *Benueites*.

Occurrence.—The holotype was found by one of us (Y.F.) from an exposure on the right bank of the Panke-moyubari [=Shimo-yubari], near 10 km point along the abandoned forestry railway in the Oyubari district. At this and adjacent localities, strata are exposed on both sides of a minor anticline. From the mudstones which are very close to that of HCS. 92 (type-locality) in stratigraphic position, one of us (Y.F.) obtained commonly *Inoceramus* (*Inoceramus*) *hobetsensis nonsulcatus* NAGAO and MATSUMOTO, and also several fragmentary ammonites, of which *Shuparoceras* sp. cf. *S. abei* MATSUMOTO (loc. 0.2) is diagnostic. These suggest the lower part of the so-called Middle Turonian in the Japanese province. Whether this is precisely correlated with the lower part of the internationally defined Middle Turonian or otherwise is uncertain. Other ammonites are *Neophylloceras ramosum* (MEEK), *Phyllopachyceras* sp., *Pachydesmoceras* sp., *Gaudryceras* sp. and *Scaphites* sp. A fragmentary large *Inoceramus* and an ostreid species were also collected there.

The paratype was obtained by another of us (MIYAUCHI) from the Chiyenaibo Formation (Cenomanian-Santonian) defined in the geological map of Chiraihetsu (OSANAI et al., 1957). More precise stratigraphic position is hardly decided from the available record.

The compared Obira specimen (T. MURAMOTO's collection) came from unit Mk of TANAKA (1963), along with *Eubostrychoceras japonicum* (YABE) (see MATSUMOTO, 1977, p. 329, 365) and *Inoceramus* (*Inoceramus*) *hobetsensis nonsulcatus*.

Ampakabites (?) sp.

Pl. 6, Fig. 2; Text-fig. 6

1909. *Mammites* sp., YABE. *Zeitsch Deut. Geol. Gesell.* **61**, p. 411 (mentioned).

Material.—A fragmentary whorl, UMUT. MM 6890 [=Cr. 370], from the

Opirashibets [=Obira] area, coll. H. YABE.

Description.—This is a fragmentary portion of a large whorl, but is still septate. Whorl-section is subrectangular, with nearly parallel flanks, subrounded umbilical and ventrolateral shoulders and a very gently arched venter. Measurements in costal section show: height=104.2, breadth=96.8 mm, b/h 0.93.

Two major ribs on the flank are low and much separated, about 60 mm apart in the outer lateral part. The wide interspace is smoothish on the internal mould. Each rib has a bullate tubercle at the umbilical shoulder, a moderately strong ventrolateral tubercle and a clavate tubercle at the outer end of the rib on either side of the siphonal zone, which is about 40–45 mm in breadth.

The suture is deeply incised, resulting in a narrowed stems of the lateral saddles.

Remarks.—The available material is too fragmentary for precise identification. The present description is given to stimulate further search for better preserved specimens.

Comparison.—The present species looks like a certain species of *Pseudaspidoceras* (e.g. *P. curvicostatum* REYMENT, 1955) in the high rectangular whorl, distant ribbing and the general configuration of tubercles, but its suture is too deeply incised for that genus. On this account it may be assigned to *Ampakabites*, but it is not identified with any of the hitherto known species of that genus in its distant ribbing.

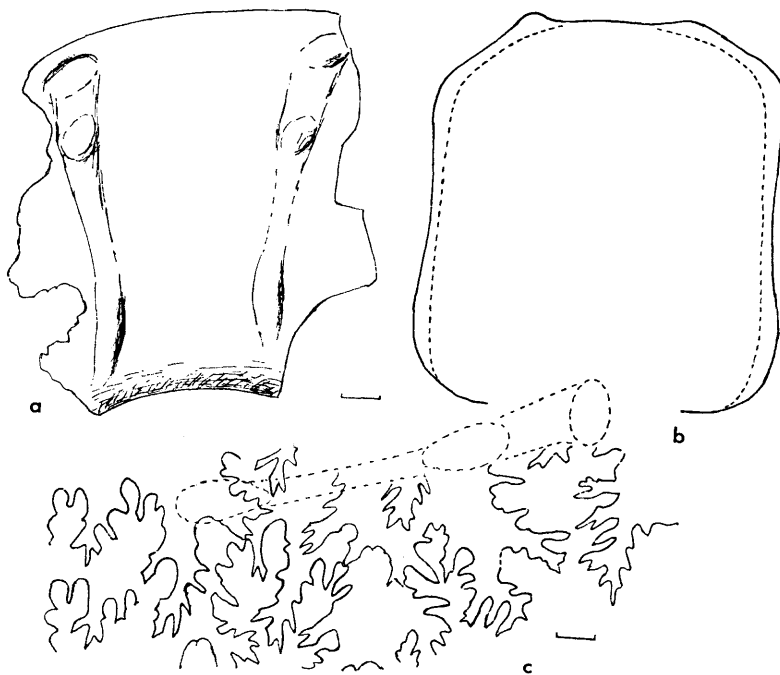


Fig. 6. *Ampakabites* (?) sp.

Diagrammatic sketch of UMUT. MM6890. Lateral view (left), whorl section (right) and external suture (below). Bar shows 10 mm.

(T. MATSUMOTO *delin.*)

The whorl-section of this species is somewhat similar to that of *Ampakabites collignoni* COBBAN and SCOTT (1972, p. 81, text-fig. 39), from the Lower Turonian of Colorado, but that species has more compressed whorls on which ribs are often looped at the ventrolateral tubercles and less distant than in the present species.

For the time-being this specimen is labelled as *Ampakabites* (?) sp.

Occurrence.—The locality record given by YABE is “from the Opirashibets [=the River Obirashibe in modern geographic map], province of Teshio”. This is too general to be pin-pointed on the recently published geological maps (e. g. TANAKA, 1963; TANABE et al., 1977).

Part IV

Description of Some Species of *Pseudaspidoceras* and an Allied New Genus from Hokkaido and Saghalien (T. MATSUMOTO)

Genus *Pseudaspidoceras* HYATT, 1903

Pseudaspidoceras sorachiense MATSUMOTO and HASHIMOTO

1953. *Pseudaspidoceras sorachiense* MATSUMOTO and HASHIMOTO, *Trans. Proc. Palaeont. Soc. Japan*, N.S. No. 12, p. 101, pl. 10, fig. 1.

Remarks.—This was established on a single holotype. Since then no additional specimens have been obtained from Hokkaido. As was originally pointed out, it is allied to *P. salmuriense* (COURTILLER), from France, especially to a form from Tunisia called var. *byzacenica* by PERVINQUIÈRE (1907, p. 315, pl. 19, fig. 1) and also an example from Israel illustrated by FREUND and RAAB (1969, pl. 5, figs. 5–6), in the distant, less numerous ribs. There could be, therefore, a possibility that these forms might represent a Tethys-Pacific subspecies. Until sufficient material be assembled, I follow the original nomenclature for the species from Hokkaido.

Incidentally, *P. salmuriense* was referred to *Kamerunoceras* by COLLIGNON (1965), but I hesitate to agree with his assignment. As was clearly described by COURTILLER (1867, p. 6) and reillustrated in *Paleontologia Universalis* (6), there is no tubercle on the siphonal line in both immature and outer whorls of

Explanation of Plate 5

- Fig. 1. *Pseudaspidoceras* sp. aff. *P. footeanum* (STOLICZKA)Page 11
GK. H5869, from loc. R5211 g of the Obira area. Lateral view of a
fragmentary whorl, $\times 2/5$.
- Fig. 2. *Ampakabites regina* MATSUMOTO, FUJISHIMA and MIYAUCHI, n. sp. ...
.....Page 11
Holotype (see Pl. 4, Fig. 1). The other lateral view, $\times 1/2$.
Kyushu Univ. (K. TANABE) photos, without whitening.





1 a



1 b



2 a



2 b

the figured types, but for an indistinct undulating keel like elevation. For the time being I would follow PERVINQUIÈRE (1907) to refer this species to *Pseudaspidoceras*.

Occurrence.—Loc. KY 301b, Shimo-Kanayama, central Hokkaido. From an approximate extension of the same member at loc. KY 9E (see map of MATSUMOTO and HASHIMOTO, 1953, fig. 1), occurred *Inoceramus* (*Mytiloides*) of *labiatus* group (see MATSUMOTO and NODA, 1975, pl. 18, figs. 1 and 4).

Pseudaspidoceras sp. aff. *P. footeanum* (STOLICZKA)

Pl. 5, Fig. 1

Material.—GK. H5869, from loc. R5211 g, found by K. TANABE in a field work with H. HIRANO and T. MATSUMOTO (1974.8.11).

Description.—This consists of two detached fragmentary pieces of probably a large body-whorl, with height over 120 mm. The whorl is probably compressed, with a fairly narrow venter, gently sloping ventrolateral shoulder, nearly flat flank, abruptly rounded umbilical shoulder, and low but steep umbilical wall. As the other side of the whorl has been dissolved away the precise measurements is impossible.

There are much distant major ribs, each of which has a small but pointed tubercle at the umbilical shoulder, a bullate weak elevation at the ventrolateral shoulder and a clavate tubercle of low to moderate height on either side of the mid-ventral zone. There are several minor ribs and numerous parallel lirae on the broad interspace of the major ribs. The minor ribs are weaker and narrower than the major ones but start from the umbilical margin. Some of them have a bulla at the umbilical shoulder. The ribs are nearly rectiradiate or slightly rursiradiate on the main part of the flank and gently projected on the ventrolateral part and on the umbilical wall.

Suture is unknown.

Comparison.—The specimen is too incompletely preserved for accurate identification. Its observable characters suggest some similarity to *P. footeanum*, but the inner ventrolateral tubercles are weaker and the whorl seems to be more compressed than in that species.

Occurrence.—Loc. R5211 g, on the left bank of the River Obirashibe, about 400 m upstream from the confluence with the tributary Kanajiri-zawa (see TANABE et al., 1977, fig. 6 for the location). The host mudstone at R5211 (7–8 m,

Explanation of Plate 6

- Fig. 1. *Polyaspidoceras shimizui* MATSUMOTO, n. sp.Page 18
Holotype, IGPS, 54404, from the Miho, Naibuchi area, South Saghalien.
Lateral (a) and ventral views, $\times 1$.
Tohoku Univ. (K. KUMAGAI) photos, without whitening.
- Fig. 2. *Ampakabites* (?) sp.Page 14
UMUT. MM6890, from the Obira area. Natural whorl-section (a) and
lateral view (b), $\times 4/5$.
Univ. Tokyo (C. UEKI) photos, without whitening.

thick) below a tuffaceous layer (0.4 m) contain other calcareous nodules in which *Inoceramus* aff. *saxonicus* PETRASCHECK commonly occurred and some large specimens of *Mesopuzosia* or *Pachydesmoceras* were found. This belongs to Member Mj of TANAKA (1963). In the rock matrix of the body-chamber of this specimen many fragmentary, thin shelled bivalves, including *Inoceramus*, are deposited showing a laminated structure. Undetermined microfossils are also met with.

In addition to the two species of *Pseudaspidoceras* there is a new species for which a new genus is proposed.

Genus *Polyaspidoceras* nov.

Type-species.—*Polyaspidoceras shimizui* sp. nov.

Diagnosis.—Whorls rather flat-sided, with a subrectangular cross-section; ribs weak to moderate, and fairly distant. Sutures of *Acanthoceras* pattern.

Tubercles are prominent at an inner laterl point and at the inner ventrolateral shoulder, clavate and of moderate intensity on the outer ventrolateral part, smaller and weaker at the umbilical shoulder and at an outer lateral point, and undeveloped on the siphonal line.

Remarks.—About 12 years ago I noticed the presence of a multituberculate mammitine ammonite, but the material was so insufficient that I postponed to describe it. A few years ago I noticed another example in the collection of Tadashi KAWANO. The characters were distinct but shown on an incompletely preserved specimen. I am afraid that too long wait might miss the opportunity to report these interesting ammonites. So I decide to describe them here, despite some deficiency in the available material. I hope this description would stimulate people to search for better preserved specimens.

Discussion.—This new genus is similar to *Pseudaspidoceras* in shell form and rather weak and distant ribbing. It is, however, distinguished from it by the additional two rows of tubercles on the flank.

Polyaspidoceras shimizui sp. nov.

Pl. 6, Fig. 1; Text-fig. 7

Material.—Holotype, IGPS. 54404, from the Miho, Naibuchi area, South Saghalien (coll. S. SHIMIZU).

Description.—The holotype is about a half whorl, consisting of the last portion of the septate stage and the body-chamber.

The whorl is higher than broad, increasing slowly with growth. Its flank is nearly flat or only slightly convex and the umbilical wall is low, with subangular umbilical shoulder.

There are 8 ribs on the preserved part of the whorl, of which 3 are shorter and alternated with the longer ones. The ribs are low, gently prorsiradiate or gently flexiradiate, narrow around the umbilicus and gradually broadened outward toward the venter. They are separated by a fairly broad interspaces. On the preserved last part there is no shorter rib and the longer ribs are disposed

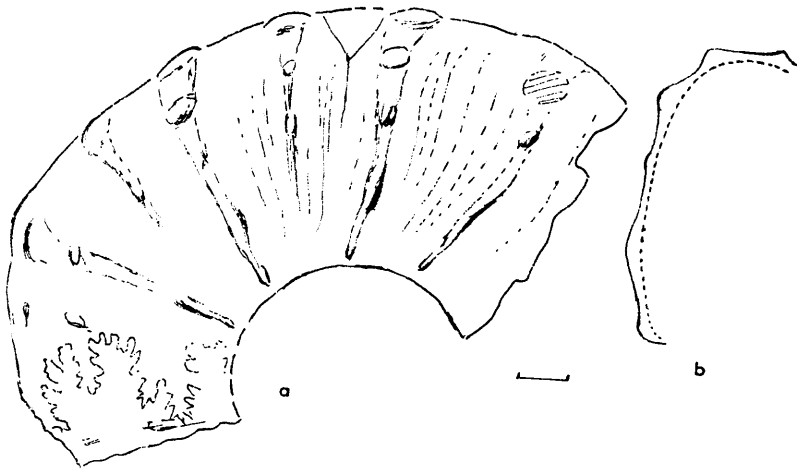


Fig. 7. *Polyaspidoceras shimizui* MATSUMOTO, n. sp.

Diagrammatic sketch of the holotype, IGPS. 54404.

Lateral view and whorl-section (incomplete). Bar shows 10 mm.

(T. MATSUMOTO *delin.*)

at a wider interval. On the interspaces fine lirae may be discernible.

The long rib has a weak bulla at the umbilical shoulder and a stronger, radially elongated tubercle at an inner lateral point somewhat below the mid-flank. These tubercles are not developed on the extension of a shorter rib. Every rib has a small, weak tubercle at an outer lateral point, a somewhat clavate tubercle at the ventrolateral shoulder and another clavate tubercle on either side of the nearly flat or slightly concave siphonal zone. The ventrolateral tubercle is prominent on the long rib but weaker on the short rib.

The suture is moderately incised, having the squarish first lateral saddle and L of moderate breadth.

Remarks.—As the septate whorls are mostly missing, the characters of the immature shell is unknown.

Comparison.—Although the shell-form of the present species resembles that of certain species of *Pseudaspidoceras*, the persistency of shorter, intercalated ribs up to the middle of the body-whorl is peculiar to this species. The multi-tuberculation is diagnostic enough to distinguish this species from any other known species.

Occurrence.—"The Miho, a tributary of the Naibuchi River in South Saghalien." The very point is not indicated in the label, but SHIMIZU (1935, p. 175) set up the Zone of *Pseudaspidoceras* cf. *armatum* on the basis of this ammonite.

Polyaspidoceras sp.

Text-fig. 8

Material.—A specimen in T. KAWANO's collection from the Sato-no-sawa (main course), Obira area.

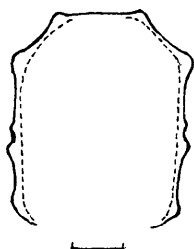


Fig. 8. *Polyaspidoceras* sp.
Whorl-section of T. KAWANO'S specimen, from the
Obira area. Bar shows 10 mm.
(T. MATSUMOTO *delin.*)

Descriptive remarks.—This is about 210 mm in diameter, but the body-whorl (slightly less than a half whorl) is much eroded. The whorl is fairly evolute, parallel sided and higher than broad. Ribs are moderately distant. Tubercles are at the umbilical shoulder, the lower and upper lateral parts, inner ventrolateral shoulder and upper ventrolateral point. The two lateral tubercles are approximated, of which the inner one is stronger than the outer. The suture is of *Acanthoceras* pattern.

This is dissimilar to *P. shimizui* in the approximated lateral tubercles, but is too poorly preserved to receive another new specific name.

Occurrence.—Sato-no-sawa, probably from Member Mj or TANAKA (1963), in the Obira area.

Concluding Remarks

(1) *Taxonomic results.*—Ammonites belonging to the Mammitinae have been thought as rare in the Cretaceous Japanese province. Through the present study we now have following species (*new species established in this paper):

- (1) *Sumitomoceras faustum* MATSUMOTO and MURAMOTO, 1969
- (2) *Mammites costatus* MATSUMOTO and KAWASHITA, 1978*
- (3) *Pseudaspidoceras sorachiense* MATSUMOTO and HASHIMOTO, 1953
- (4) *Pseudaspidoceras* sp. aff. *P. footeanum* (STOLICZKA, 1865)
- (5) *Ampakabites regina* MATSUMOTO, FUJISHIMA and MIYAUCHI, 1978*
- (6) *Ampakabites* (?) sp. [= *Mammites* sp. of YABE, 1909]
- (7) *Polyaspidoceras shimizui* MATSUMOTO, 1978*
- (8) *Polyaspidoceras* sp.

(2) *Distribution.*—The said rarity has owed partly to a collection failure and partly to a delay in description. In fact ammonites belonging to the Desmozeratidae, Tetragonitidae, Gaudryceratidae and Phylloceratidae occur more abundantly than those of the Acanthoceratidae and Collignoniceratidae in the Cretaceous basin of Hokkaido and Saghalien, called the Yezo geosyncline. This is, however, due to the environmental conditions that the sediments are mostly muddy and of off-shore facies facing the vast Pacific ocean. Of course there must have been sediments of shallower, near shore facies in the marginal part

of the basin, but they were distributed in narrow areas and have mostly been eroded away. This is one of the reasons why the species identical with those of the shallow epicontinental seas are absent or found rarely in the Cretaceous Japanese province.

As to the Mammitinae from Hokkaido and Saghalien, the presence of several species which are not identical with those outside this province may give a concept of endemism, but we should consider the above mentioned feature of environmental conditions.

As was discussed on a previous occasion (MATSUMOTO et al. 1969, p. 285) *Sumitomoceras faustum* closely resembles *S. amudariense* (ARKHANGUELSKY), from Turkestan, and *S. ushas* (STOLICZKA), from southern India. *Pseudaspidoceras sorachiense* is closely allied to and might be regarded as a subspecies of *P. salmuriense* from western Europe, North Africa, the Middle East and Madagascar. Another species of *Pseudaspidoceras* is allied to *P. footeanum* from southern India. Thus, we do not regard the specific composition of our Mammitinae fauna as implying the true endemism due to an isolated palaeogeography.

It should be noted, furthermore, that most of the hitherto obtained specimens of the Mammitinae (and other Acanthoceratidae) from our off-shore facies are adult shells with a well preserved body-chamber. This probably implies a calm sedimentological condition and also suggests a wider habitat distribution of some, if not all, acanthoceratid species than previously considered. Immature acanthoceratid species may have had a more restricted habitat in shallower, near-shore environments.

(3) *Correlation*.—Like other acanthoceratids *Mammites* and allied ammonites are important for the biostratigraphic subdivision and interregional correlation.

Sumitomoceras faustum occurs in the Zone of *Kanabicerias septemseriatum* in the Ikushumbetsu sequence (central Hokkaido), which is probably Uppermost Cenomanian in a revised scheme. *Mammites costatus* occurs in the probable correlative of Lower Turonian in the sequences of the Oyubari and the Obira areas (Hokkaido). *Pseudaspidoceras sorachiense* was found in a member containing *Inoceramus* (*Mytiloides*) of the *labiatus* group (probably *I. (M.) mytiloides*), which indicates, according to KAUFFMAN (1977), middle Lower Turonian. *Pseudaspidoceras* aff. *footeanum* came from the Lower Turonian in the Oyubari section. The holotype of *Ampakabites regina* was obtained in the lower part of the zone of *Inoceramus hobetsensis*, which we consider probably lower Middle Turonian but might be upper Lower Turonian. This should be compared with the fact that *A. auriculatus* occurs in the Zone of *Mammites conciliatus* of Madagascar, which was referred to Middle Turonian by COLLIGNON (1965). It is recalled here that *Mammites mocamedensis* is reported by HOWARTH (1966) at about the mid-Turonian in Angola. The genus *Mammites* characterises Lower Turonian but seems to range up to mid-Turonian. For the last three of the species described in this paper the available locality records are too general to state their precise stratigraphic positions, although lower half of the Turonian may be suggested.

(4) *Evolutionary History*.—Lastly let us summarize briefly the evolutionary history of the Mammitinae. The ultimate origin of *Mammites* and its allied genera is in *Protacanthoceras-Neocardioceras* of the Acanthoceratinae, as Wright (1957) has pointed out. *Watinoceras* and *Sumitomoceras* are the oldest genera of the Mammitinae and in sisterhood relationship. They range from the uppermost Cenomanian to the lowest Turonian. They are comparatively small. *Mammites* is probably a derivative of *Watinoceras*, becoming larger, thicker and more coarsely ornamented than its ancestor. It predominates in the Lower Turonian but some species range up to the mid-Turonian. *Pseudaspidoceras* is in sisterhood relationship with *Mammites* and occurs in the Lower Turonian. *Polyaspidoceras* and *Ampakabites* were presumably offshoots of *Pseudaspidoceras* and *Benueites* respectively. *Benueites* was probably derived from *Watinoceras*.

To sum up, the subfamily Mammitinae were differentiated rather spontaneously within a short time-interval near the Cenomanian-Turonian boundary, prospered in the Early Turonian time and disappeared before the mid-Turonian.

Acknowledgements.—We thank Mr. C. W. WRIGHT, Drs. W. A. COBBAN, R. A. REYMENT and W. J. KENNEDY for valuable suggestions, Drs. I. HAYAMI, H. HIRANO and K. TANABE and Messrs. T. & K. MURAMOTO, H. HONDA, T. TAKAHASHI and T. KAWANO for their help in various ways. The specimen of SHIMIZU's collection was studied, when I visited Tohoku University, where the late Dr. HATAI gave me facilities.

The symbols to denote the institutional repositories are as follows:

GK: Department of Geology, Kyushu University, Fukuoka

HCS: Geological Survey of Hokkaido Colliery & Steamship Co., Yubari

IGPS: Institute of Geology & Palaeontology, Tohoku University, Sendai

UMUT: University Museum, University of Tokyo, Hongo, Tokyo

Other private collections are indicated as they are.

This work is a contribution to IGCP Project Mid-Cretaceous Events. It was financially supported by the Science Research Fund (no. 154280) of the Ministry of Education, Science and Culture (*Monbusho*).

References cited

- ARKHANGUELSKY, A. D. (1916): Mollusques du Crétacé supérieur de Turkestan. *Mém. Com. Géol. Petrograd*, NS., 152, 1–57, pls. 1–8.
- COBBAN, W. A. and SCOTT, G. R. (1972): Stratigraphy and ammonite fauna of the Graneros Shale and Greenhorn Limestone near Pueblo, Colorado. *U. S. Geol. Surv. Prof. Paper*, 145, 1–108, pls. 1–39.
- COLLIGNON, Maurice (1965): *Atlas des Fossiles Caractéristiques de Madagascar* (Ammonites), 12 (Turonien), iv+82 p., pls. 376–413. Serv. Géol. Tananarive.
- COURTILLER, M. A. (1867): Les ammonites du Tuffeau. *Ann. Soc. Lin. Maine et Loire, Angers*, 9, 8 p., 8 pls. [inaccessible, but *Ammonites salmuriensis* reproduced in *Paléont. Universalis*, ser. 1, (6).]
- FREUND, R. and RAAB, M. (1969): Lower Turonian ammonites from Israel. *Spec. Pap. in Palaeont.*, (4), 1–83, pls. 1–10.
- HIRANO, Hiromichi, MATSUMOTO, Tatsuro and TANABE, Kazushige (1977): Mid-Cretaceous stratigraphy of the Oyubari area, central Hokkaido. *Palaeont. Soc. Japan Spec. Pap.*, (21), 1–10.

- HOWARTH, M. K. (1966): A mid-Turonian ammonite fauna from the Moçâmedes desert, Angola. *Garcia de Orta* (Lisboa), 14, (2), 217-228.
- HYATT, Alpheus (1903): Pseudoceratites of the Cretaceous. Edited by T. W. STANTON. *Monogr. U.S. Geol. Surv.*, 44, 351 p., 47 pls.
- KAUFFMAN, E. G. (1977): Systematic, biostratigraphic, and biogeographic relationships between middle Cretaceous Euramerican and North Pacific Inoceramidae. *Palaeont. Soc.. Japan Spec. Pap.*, (21), 169-212.
- KOSSMAT, Frantz (1897): Untersuchungen über die südindische Kreideformation. *Beitr. Paläont. Geol. Öst.-Ung.*, 11, 1-46, pls. 1-8.
- LAUBE, C. C. and BRUDDER, G. (1887): Ammoniten der böhmischen Kreide. *Palaeontographica*, 33, 217-239, pls. 23-29.
- MATSUMOTO, Tatsuro (1977): Some heteromorph ammonites from the Cretaceous of Hokkaido. *Mem. Fac. Sci., Kyushu Univ.*, ser. D, Geol., 23, (3), 303-366, pls. 43-61.
- MATSUMOTO, Tatsuro and HASHIMOTO, Wataru (1953): A find of *Pseudaspidoceras* from Hokkaido, Japan. *Trans. Proc. Palaeont. Soc. Japan*. N. S., (12), 97-102, pl. 10.
- MATSUMOTO, Tatsuro, MURAMOTO, Tatsuo and TAKAHASHI, Takemi (1969): Selected acanthoceratids from Hokkaido. *Mem. Fac. Sci., Kyushu Univ.*, ser. D, Geol., 19, (2), 251-296, pls. 25-38.
- MATSUMOTO, Tatsuro and OKADA, Hakuyu (1972): Saku Formation of the Yezo geosyncline. *Sci. Repts. Dept. Geol., Kyushu Univ.*, 11, (2), 275-309 (in Japanese with English abstract).
- MORROW, A. L. (1935): Cephalopods from the Upper Cretaceous of Kansas. *Jour. Paleont.*, 9, 463-473, pls. 49-53.
- OSANAI, Hiroshi, MITANI, Katsutoshi and ISHIYAMA, Shozo (1957): Chiraiibetsu. *Expl. Text Geol. Map Japan*, scale 1: 50,000, 44 p., 1 pl. (in Japanese with English abstract), Hokkaido Develop. Agency.
- PERVINQUIÈRE, L. (1907): Études de paléontologie tunisienne. I. Céphalopodes des terrains secondaires. *Carté géol. Tunisie*, Texte, 428 p., Atlas, 27 pls.
- REYMENT, R. A. (1954a): New Turonian (Cretaceous) ammonite genera from Nigeria. *Colonial Geol. Min. Resources*, 4, (2), 149-164, pls. 3-4.
- (1954b): Some new Upper Cretaceous ammonites from Nigeria. *Ibid.*, 4, (3), 248-270, pls. 1-5.
- (1955): The Cretaceous Ammonoidea of southern Nigeria and the southern Cameroons. *Bull. Geol. Surv. Nigeria*, (25), 1-112, pls. 1-25.
- SHIMIZU, Saburo (1935): The Upper Cretaceous cephalopods of Japan. Part I. *Jour. Shanghai Sci. Inst.*, ser. 2, 2, 159-226.
- SOLGER, F. (1904): Die Fossilien der Mungokreide in Kamerun und ihre geologische Bedeutung. *Beitr. Geol. Kamerun*, 85-242, 3 pls.
- SPATH, L. F. (1935): On a Turonian ammonite (*Mammites daviesi*) from Ramri Island, Burma. *Records Geol. Surv. India*, 68, 414-416, pl. 32.
- TANABE, Kazushige, HIRANO, Hiromichi, MATSUMOTO, Tatsuro and MIYATA, Yuichiro (1977): Stratigraphy of the Upper Cretaceous deposits in the Obira area, north-western Hokkaido. *Sci. Repts. Dept. Geol. Kyushu Univ.*, 12, (3), 181-202 (in Japanese with English abstract).
- TANAKA, Keisaku (1963): A study on the Cretaceous sedimentation in Hokkaido, Japan. *Rept. Geol. Surv. Japan*, (197), 119 p. (in English) + 3 p. (abstract in Japanese), folded maps, 3 pls.
- WRIGHT, C. W. (1957): In MOORE, R. C. (ed.): *Treatise on Invertebrate Paleontology*, Part L, Mollusca, Cephalopoda, Ammonoidea, p. L 1-L 490, Geol. Soc.. Amer. & Univ. Kansas Press.
- YABE, Hisakatsu (1909): Zur Stratigraphie und Paläontologie der oberen Kreide von Hokkaido und Sachalin. *Zeitsch. Deut. Geol. Gesell.*, 61, 402-444.

- (1926): A new scheme of the stratigraphical subdivision of the Cretaceous deposits of Hokkaido. *Proc. Imp. Acad. Japan*, 2, 214–218.
- (1927): Cretaceous stratigraphy of the Japanese Islands. *Sci. Rept. Tohoku Imp. Univ.* 2nd ser., 11, (1), 27–100, pls. 3–9.