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A gigantic ammonite from Hobetsu, Hokkaido

(Studies of Cretaceous ammonites from Hokkaido—LXIV)

by

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Abstract. －A huge ammonite, now held in the Hobetsu Museum (HMG-344), came from the Middle Turonian mudstone in the head-waters of the Takikawa-no-sawa, a tributary to the River Hobetsu, southern central Hokkaido. It is one of the best preserved macroconchs of *Pachydemoceras pachydiscoide* MATSUMOTO, 1954 (Puzosiidae) in showing a nearly complete living chamber as well as the preceding septate whorls. It is just 1000 mm in diameter behind the arcuate and rostrated apertural margin. The adoral main part of the living chamber is extraordinarily inflated. This is not pathologic, because the same character is recognized in several other examples of this species and because similar kinds of broadening occur in certain other genera. Presumably, this feature may manifest an egg-laying stage of a full-grown female form of this ammonite species, who herself must have had a vigorous fertility.

Key words–dimorphism, living chamber, macroconch, *Pachydesmoceras*, Puzosiidae

I Introduction

Hobetsu is celebrated for the occurrences of various kinds of fossils as well as a wealth of living organisms. Hobetsu Museum is certainly a center of activities for research as well as educational purposes upon them. The enthusiastic hunting and fresh discoveries of fossil vertebrates from the Cretaceous and Tertiary outcrops in the Hobetsu and adjacent areas, followed by intensive scientific research works by specialists and display of the results to the public are outstanding examples of such activities.

The Hobetsu area is also rich in fossil invertebrates and has a history of research works for generations. For instance, the specific names taken from

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the place names related to this area such as *Tetragonites popetensis* * YABE, 1903, *Inoceramus hobetsensis* NAGAO et MATSUMOTO, 1939 and *Inoceramus iburiensis* * * NAGAO et MATSUMOTO, 1939 mark some steps in the history of investigations.

Incidentally, the lectotype of *Inoceramus hobetsensis* designated by NODA(1975, p. 249) is a huge pelecypod specimen illustrated by MAGAO and MATSUMOTO (1939, pl. 29, fig. 3) and now held in the Institutute of Geology and Mineralogy, Hokkaido University, Sapporo. Its original locality is probably the outcrop of loc. H2464 on the main course of the River Hobetsu as indicated in text-fig. 6 by MATSUMOTO *et. al.* (1989).

A great size of an organism has various aspects of scientific interests and for a museum it works as an attractive object for visiting people. Here is a gigantic ammonite which was obtained from an outcrop of Cretaceous rock in the Hobetsu area and has been kept in the Hobetsu Museum. This paper gives a result of my palaeontological study of that giant.

II Palaeontological description

Pachydesmoceras pachydiscoide MATSUMOTO
Plate 1;Plate 2, figs. A, B;
Text-figs. 1-3

1954, *Pachydesmoceras pachydiscoides (sic.)* MATSUMOTO, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., vol. 5, no. 2, p. 101, pl. 9, fig. 2.

1988, *Pachydesmoceras pachydiscoide* MATSUMOTO; MATSUMOTO *et al., Palaeont. Soc. Japan Spec. Pap.*, no. 30, p. 127, figs. 56-60(with full list of synonyms).

Material and occurrence. —HMG-344, a single huge specimen found by Noboru SAITO in May, 1980. It was in a huge calcareous nodule which cropped out from the mudstone at loc. H2530 on the northwest side of a stream in the headwaters of the Takikawa-no-sawa, a tributary to the River Hobetsu. It was excavated in late May, 1980 and brought to the office by a group of persons organized by the Hobetsu Board of Education. Since the opening of the Museum, in July 1982, this specimen has been on display in the Hobetsu Museum. The host rock is referred to the Middle Turonian on the evidence described in a paper written in Japanese (MATSUMOTO *et al.*, 1989) in this Bulletin. See also maps of text-figs. 1 and 2 in that paper for the geographic location.

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* Popets: a place name of the Ainu, from which Hobetsu was derived.

* * Iburi: Hobetsu belonged to the Province of Iburi in an old administrative division.

Description.—This specimen is complete in showing fully the living chamber and the last one whorl of the phragmocone, but regrettably the preceding younger parts are not well preserved. It is gigantic; its diameter measures just 1000 mm at the point immediately behind the ventral projection of the apertural margin and 790 mm at the end of the phragmocone (see Table 1).

The living chamber occupies nearly a half whorl, showing a scaphitoid unwinding tendency, and its adoral main part broadens extraordinarily, with B/H as large as 1.22 at the maximum. The flanks are broadly inflated there, stretching inward to the umbilical margin, and bent abruptly to a vertical, or even overhanging, very high umbilical wall (120 mm in maximum height). On the posterior part of the living chamber behind this inflated main part, there is a weakly concave zone, where the whorl is somewhat compressed. In compensation with much broadening, the rate of expansion in whorl-height is lowered in the living chamber. The surface of the body chamber is smooth where the shell is preserved as well as on the internal mould.

The apertural margin is concave forward on the flank and rostrate on the venter, with broad and nearly flat basal part of the rostrum. Immediately behind the peristome, there is a shallow and moderately broad constriction, which fades away outward.

The phragmocone does not show such a peculiar feature as described above. Its whorl is somewhat higher than broad and suboval in cross-section with a rather (but not very) narrowly arched veter and gently convex flanks, and broadest at a point somewhat dorsad from the mid-height. The last part (indicated as m in Text-fig. 1) of the phragmocone is slightly inflated. The rate of expansion in whorl-height is fairly high, showing 1.65 in a half whorl. The width of umbilicus is roughly 30 percent of the diameter.

The surface of the exposed part of the phragmocone looks nearly smooth, but the original ribbing may be obliterated where the outer shell layer is not preserved (see comparison below). There are constrictions and associated flares, which weaken and decome very faint at the stage about 120 adapically from the end of the phragmocone. The constriction is asymmetrically concave on the flank, showing fairly prominent ventral projection.

The sutures exposed here and there are of typical pattern of *Puzosia*, with very fine and deep incisions.

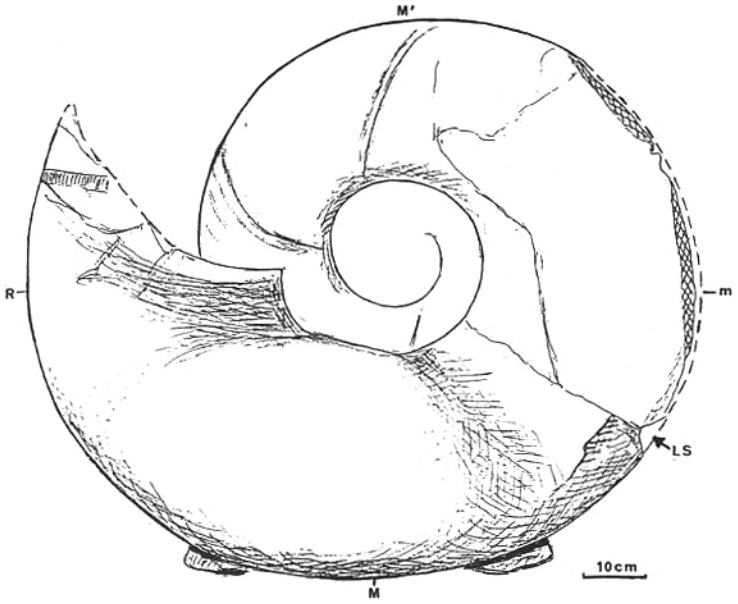
Dimensions.—See Table 1.

Comparison and discussion.—In a recently published monograph, MATSUMOTO *et al.* (1988, p. 127-134) have shown some macroconch examples of *Pachydesmoceras pachydiscoide*, in which the last whorl is peculiarly inflated in certain part (s) with weakly concave zone (s) on either or adoral side of the inflation, although the

Table 1. Measurements (in mm) of *Pachydesmoceras pachydiscoide* on selected specimens.

Specimen	Position	D	U	H	B	B/H	h	H/h
HMG-344	R	1000(1)	310(.31)	400(.40)	——	——	315	1.27
〃	X	925(1)	285(.31)	370(.40)	~450(.49)	1.22	——	——
〃	M	870(1)	260(.30)	350(.40)	——	——	280	1.25
〃	LS	790(1)	245(.31)	340(.43)	~243(.31)	0.71	205	1.66
〃	m	755(1)	225(.30)	330(.44)	~261(.34)	0.79	200	1.65
〃	M′	——	——	280	~200	0.71	——	——
YKC-590710	X	967(1)	263(.27)	395(.41)	348(.36)	0.88	316	1.25
Holotype	E	218(1)	~63(.29)	95(.44)	~75(.34)	0.79	60	1.58
GK-H5794	E	720(1)	188(.26)	325(.45)	235(.33)	0.72	205	1.58

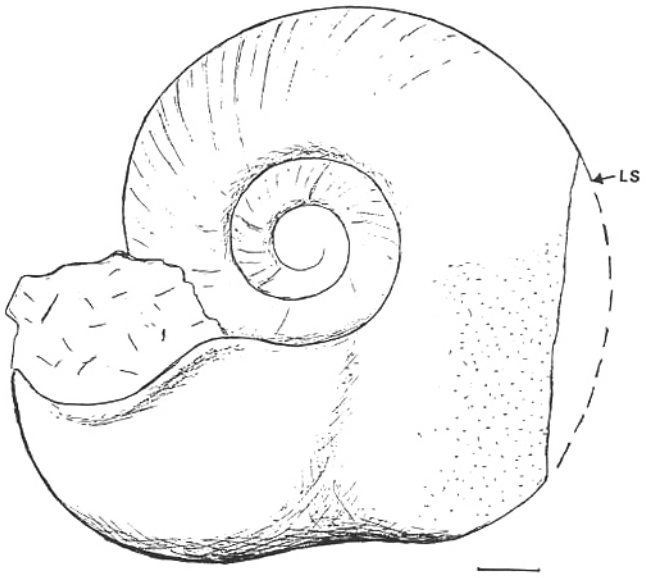
D: diameter, U: width of umbilicus, H: whorl-height, B: whorl-breadth, h: whorl-height at 180 back from H; R: base of rostrum, X: position where B is maximum, M, m, M': positions indicated as M, m, M' in text-fig. 1, LS: last seputum, E: preserved end, ~: approximate.
Holotype, UMUT. MM6660 (remeasured) is wholly septate but may be a microconch. GK-H5794 represents a late septate stage of a macroconch.



Text-fig. 1. *Pachydesmoceras pachydiscoide* MATSUMOTO.
Sketch of HMG-344 in lateral view, indicating the measured points (see Table 1). Scale bar: 100mm. T. M. *delin.*

mode of appearance of this peculiar feature varies to some extent between individuals. Two specimens of Y. KAWASHITA's Collection, among others, are fairly similar to the Hobetsu specimen. One is MCM-A92 from a Turonian bed in the head-waters of a branch of the Hinata-zawa in the Shiyubari area (indicated as no. 3 in the Material of MATSUMOTO *et al.*, 1988, p. 127) and the other is YKC-590710 from the Upper Turonian of the Shirochi-une-zawa in the Haboro area (ditto, no. 6).

MCM-A92 (Text-fig. 2) is incomplete and the phragmocone is connected with the reconstructed adapical part of the living chamber. Its scaphitoid unwinding is more remarkably manifested than that of the Hobetsu specimen. The adoral part of its living chamber is broadly inflated and finally contracted on the apertural margin, whose peristome is sinuous in lateral view and projected on the venter. On the adapical part of the inflation there is a distinctly concave part and im-mediately behind this depression the whorl is somewhat inflated. Therefore the inflation occurs twice in this living chamber and the second one is more marked than the first.

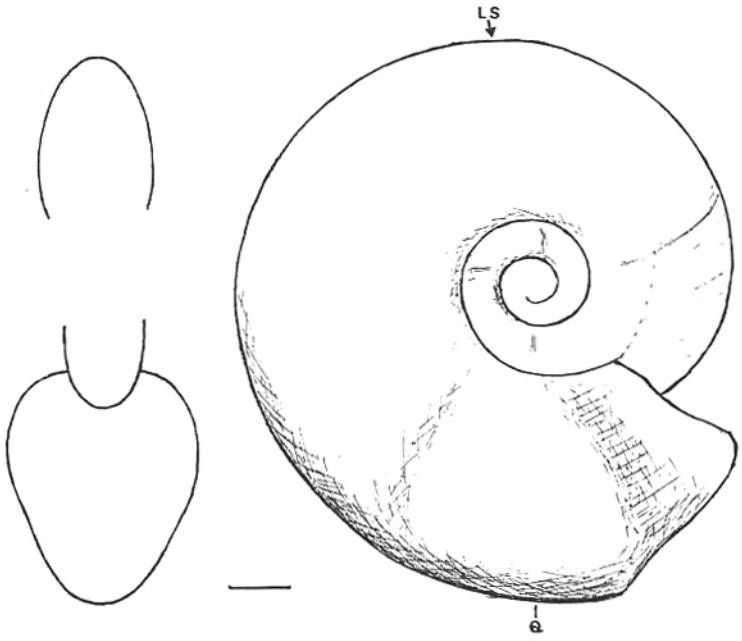


Text-fig. 2. *Pachydesmoceras pachydiscoide* MATSUMOTO.
Sketch of MCM-A92 in lateral view. Arrow indicates the position of the last septum;dotted part originally damaged but now reconstructed. Scale bar: 100mm. T. M. *delin.*

YKC-590710 (Text-fig. 3) is covered with whitish altered inner shell layer for the most part and looks smooth on the right side, but the ribs of the *P. pachydiscoide* type remains on the left side up to the point about 90 prior to the last septum. This fact suggests that the Hobetsu specimen may have been originally ribbed up to the stage where a constriction remains weakly and that the apparent smoothness may be a matter of preservation.

In this Haboro specimen (YKC-590710) the preserved late part of living chamber is gently inflated. The degree of broadening of the Haboro specimen is not so great as that of the Hobetsu specimen (see Table 1). The preserved end in front of the inflation is gently concave. According to KAWASHITA, who obtained the Haboro specimen, there was the second inflation on the last part of the living chamber, which was damaged and not brought back.

On the basis of the comparisons with these two specimens, I now understand that in the Hobetsu specimen the marked inflation of the adoral part on the living chamber is the second one and that behind the shallow depression on the back of that second inflation there is faint inflation on nearly the last part of the septate whorl (m in Text-fig. 1 and Table 1). This should be called the first inflation, although it was almost imperceptible.



Text-fig. 3. *Pachydemoceras pachydiscoide* MATSUMOTO.
Sketch of YKC-590710 in lateral view (A) and cross-section (B) at Q.
Arrow: position of the last septum. Scale bar: 100mm. T.M. *delin.*

There is one more interesting specimen which was treated by MATSUMOTO *et al.* (1988, figs. 59-60), i. e. Morita's specimen from the Kaneobetsu route of the Oyubari area. It has an inflation like that of YKC-590710 but at an earlier stage which is now in the late part of its phragmocone. The early half of its living chamber broadens to some extent without peculiar inflation, but presumably the second peculiar inflation may have occurred in the adoral part of the lost later half, as suggested by a deviated umbilical seam.

In addition to the above threes,I know at least two more gigantic macroconchs which are comparable with the Hobetsu specimen. I hope they would be reported by the persons who keep them.

Through the above comparisons, I conclude that the Hobetsu specimen shows most typically the characteristic features in adult macroconchs of *Pachydesmoceras pachydiscoide* and that there is some variation in the appearance of the lateral inflations between individuals.

III Further remsrks

In many genera and species of the Puzosiidae, the living chamber of adult macroconchs are broader than whorls of septate stage, as I have demonstrated together with coworkers (MATSUMOTO *et al.*, 1988). Depending on the knowledge on living *Nautilus* (COLLINS and WARD, 1987), this can be generally interpreted as being related to enlarging genital organs as well as the overall growth of a body from an adolescent to a full-grown stage.

In the living species of *Nautilus* the sexual dimorphism is not great. In a species studied by SAUNDERS and SPINOSA (1978) the male shell is somewhat wider to accommodate the enlarged spadix. The dimorphism in ammonites, with great difference in size, shell form, ornamentation and apertural margin of adult shells, has been studied by a number of palaeontologists, of which MAKOWSKI (1963) and CALLOMON (1963) made outstanding contributions. They thought that female ammonites take more time to grow up to be mature and are accordingly larger than male ammonites. On the evidence of a supposed egg sac discovered in the body chamber of an adult macroconch of a Jurassic species *(Eleganticeras elegantulum)*, LEHMANN (1966) proposed a view that macroconchs are shells of female ammonites and microconchs those of males. This is accepted currently by many palaeontologists and some authors believe that sexual dimorphism occurs commonly in many groups of Jurassic and Cretaceous ammonites.

The Puzosiidae in my revised sense (MATSUMOTO *in* MATSUMOTO *et al.*, 1988, p. 6) comprise good many examples of dimorphic pairs, of which some are excellent but some others are known solely by macroconchs and still in want of their counterparts.

Anyhow, the presence of huge macroconchs which show various kinds of shell-

form and ornamentation in the family Puzosiidae may not only imply generally vigorous activities of their female life but also represent diverse mode of life in accordance with the respective characteristics of genera and species.

Then, what does the peculiar inflation on the normally adoral part of the living chamber in macroconchs of *Pachydesmoceras pachydiscoide* mean? I never regard this kind of inflation as pathologic or malform, because examples are not rare and because there are other kinds of broadening in some other puzosiid species.

As in the case of the living cephalopods, the reproductive organs should be located in the posterior part of the mantle cavity and would not be directly related to the peculiar inflation of the adoral part. I propose here two hypotheses to explain that particular character. One is to have an extraspace to let a smaller male come in for copulation with herself. The other is to have an enough space to form a considerably large egg capsule (or capsules) before her egg-laying.

Although a completely preserved microconch of *P. pachydiscoide* up to the apertural margin has yet to be searched for, a male of this species is not so small as to allow his whole body get into a macroconch body chamber (see Table 1). Therefore, the first hypothesis is not warrantable.

The second, motherhood hypothesis seems to be more natural and reasonable. As in the case of living *Nautilas* (see WARD, 1987, Chapter 5) a large female organ termed the nidamental gland may have been located at the rear of the mantle cavity. The secretion from this gland is said probably used to glue eggs together into strings or bunches, or generally egg formation (LEHMANN, 1981; WARD, 1987). The egg capsule(s) thus formed must have been located in the adoral part of the mantle cavity, being ready to be laid outside the living chamber on some suitable substances at the bottom of the sea-water. The peculiar inflation may imply fairly large size of an egg capsule or plural number of egg capsules.

The existence of two (or more?) inflatations at some distance in the last whorl may imply the period of egg-laying. I presume that first inflation worked when it was on the adoral part of the then living chamber at the adolescent or early mature stage. The shell growed on still, and the second, larger inflation appeared on the adoral part of the living chamber of a full-grown (or late mature) female ammonite, while the site of the first inflation may have been septate. The period may be annual or otherwise. Anyhow, the female ammonite had an ability of multiple fertilization and egg-laying from the adolescent to full-grown stages, although there may have been a periodicity in that activity.

Turning back to the odd-shaped inflation of the conch, the broaden adoral part of the living chamber with a wide and rather flat venter and with a scaphitoid

unwinding shape may have been favorable for the female ammonite to settle herself on the sea bottom at the time of egg-laying. Similar postures of female ammonites have been considered for the macroconchs of several other species, e. g. *Grandidiericeras nagaoi* MATSUMOTO et SAITO, 1987 (whose living chamber is reversed trapezoidal in cross-section with diverging flanks), *Hyperpuzosia tamon* MATSUMOTO *et al.*, 1988 (whose living chamber is depressed and has thick ribs with ventrolateral horns), *Pterapuzosia kawashitai* MATSUMOTO, 1988 (whose living chamber has two pairs of nodate, winglike protuberances where whorl is unusuallv broaden) and *Epipuzosia maya* MATSUMOTO et KAWASHITA, 1988 (whose adoral part of the living chamber is gently inflated and stretched inward on the umbilical margin, showing a scaphitoid unwinding as in *P pachydiscoide*.

In addition to the completely preserved macroconch of *P. pachydiscoide* reported herein, incomplete or destroyed large shells of probably the same species occur here and there in the Middle to Upper Turonian of Hokkaido. To find the egg capsule(s) in their living chamber would sevrve to improve the still speculative interpretation written above.

Anyhow, the huge macroconchs with broadened living chamber in various kinds of the Puzosiidae and their fairly frequent occurrences in the Cretaceous rock of Hokkaido gives us an impression that they must have had a vigorous life and great fertility.

Acknowledgements

I very much appreciate the keen sight of Mr.Noboru SAITO who found this gigantic ammonite in a depth of forest and also the laborious work of a group of persons who excavated and brought it down to the preparatory office of the Museum. I am much indebted to the authorities of the Board of Education of Hobetsu Town and the Hobetsu Museum who have given me every facility to study this valuable specimen. I thank especially Dr. Tsutomu CHITOKU of the Museum for his kind help in various ways. Thanks are extended to Drs. Masayuki NODA and Seiichi TOSHIMITSU and also Mr. Kesao KASAMAKI for their cooperation in the field work and also to Mr.Yoshitaro KAWASHITA for his kindness to show me the two gigantic specimens of his collection. Photos were taken by Dr. M. NODA. Miss Saiko FUTANI assisted me in preparing the typescript.

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北海道穂別産の巨大アンモナイト（和文要旨）

穂別町立博物館に展示の登録番号HMG-344の巨大アンモナイトは、穂別川支流、滝川の沢の奥の露頭から、1980年5月に発見・発掘・運搬された。その経緯と産出地点の詳細ならびに層位については、本号に和文で松本・野田・利光が記述している。それによれば、この化石を含有していた地層（主として泥岩）は上部白亜系チューロニアン階の中部に属する。

この標本はプゾシア類（Family Puzosiidae）の*Pachydesmoceras pachydiscoide* MATSUMOTOに同定されるが、同種の性的二型のM殻（マクロコンク）の典型的な形質を示すので、詳しく記載・図示した。住房がほぼ完全に保存されており、殻口縁の基部で直径が100cmある。気房部では螺環の増大率が高く、横断面が卵型であるが、住房では幅が広くなる代わりに高さの増大が鈍り、巻き戻しの傾向を示し、スカファイテス様である。殻口縁の若干後ろ、約100°の部分が異常な膨らみを呈する。殻口縁では殻がやや引き締まり、外面に口ばし状突起があるが、その基部は広い。他方膨らみの背後には浅い凹部があり、さらにその後ろの気房最終部は軽微だが相対的に膨らみがある。

穂別の標本を従来私が扱った本種の大型M殻と比較すると、若干の個体差はあるが、成年の前期から後期にかけて少なくとも2回、各回の殻口縁背後で殻の膨らみを示す。そのうちの2回目（最盛期？）の膨らみは異常で、住房全体も特異な形態を呈する。

上記の形質の意味について性的二型の観点から考察を試みた。プゾシア類の大型の♀は特異形が多く、旺盛な生活力を想起させる。住房は海底での産卵に好都合な座りの良い形態を各属種ごとに持っている。本種の特異形質もそのように解釈できる。産卵能力の期間、産卵の周期性、さらに卵嚢の大きさやその形成・出産までに要する期間など不明な点が多いが、本種のM殻に見る特異な形質にはこれら諸点の研究を促すものがある。

Explanation of plate I

Pachydesmoceras pachydiscoide MATSUMOTO.

HMG-344 from loc. H2530 in the head waters of the stream Takikawa-no-sawa, Hobetsu area. Left lateral view of a macroconch.

Scale bar: 100 mm. Photo by M.NODA.

Explanation of plate II

Pachydesmoceras pachydiscoide MATSUMOTO.

HMG-344. Frontal (A) and back (B) views of a macroconch.

Scale bar: 100 mm. Photos by M.NODA.

Plate I (T.MATSUMOTO)

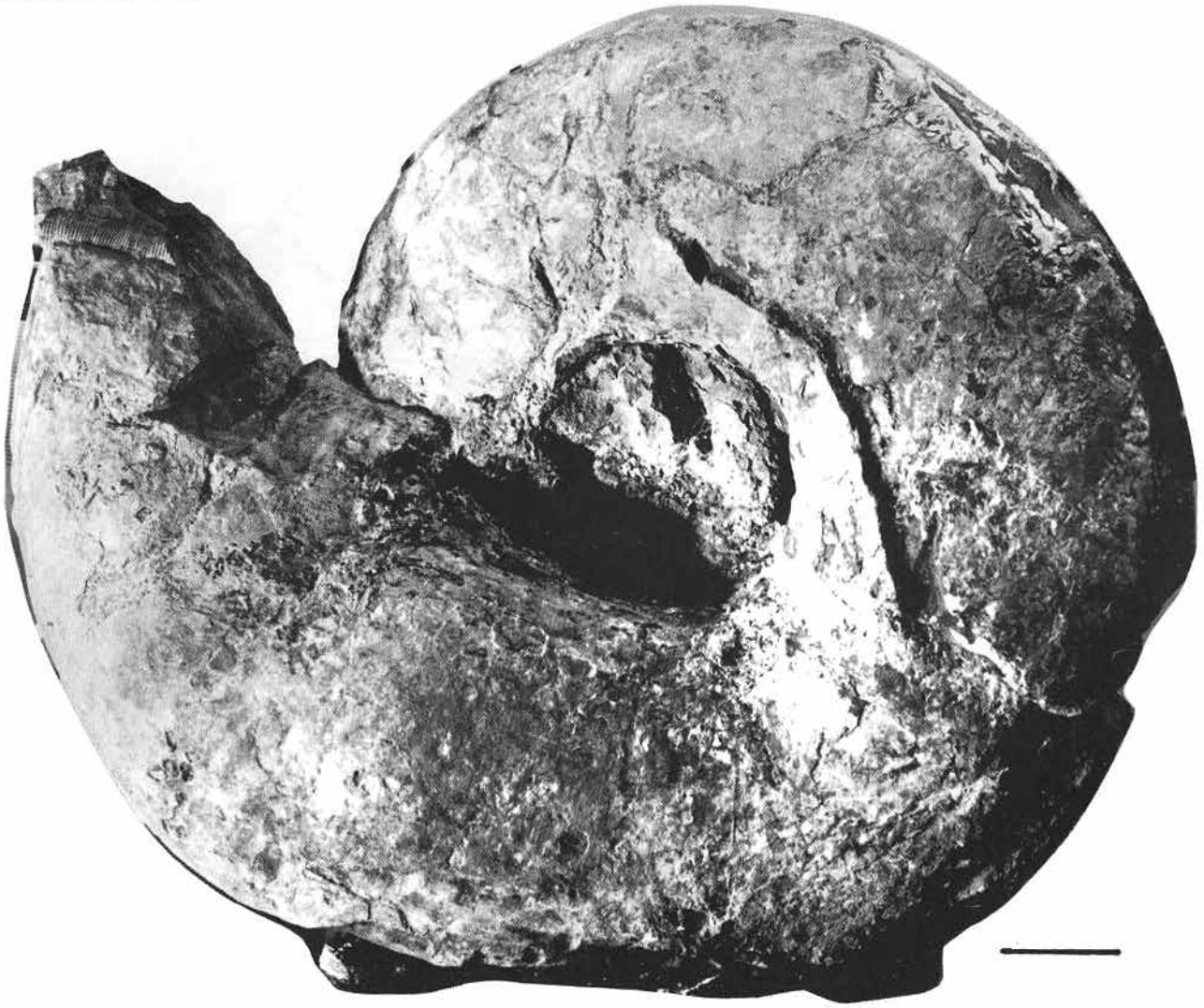

Plate II (T.MATSUMOTO)