

Early Cenomanian (Cretaceous) ammonoids *Utaturiceras* and *Graysonites* from Hokkaido, North Japan

(Studies of the Cretaceous ammonites from Hokkaido and Sakhalin-XCV)

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Abstract: Three species of the ammonoid genus *Utaturiceras*, including *U. chrysanthemum* sp. nov., and two species of *Graysonites*, from the Soeushinai area of northwestern Hokkaido, are described under revised diagnoses of the genera. They form the basal subzone of the Cenomanian sequence of strata in the studied area. This faunule is recognized in restricted parts of Japan and the correlatable faunule is also known in certain particular provinces of long distance in the world. The reason for this fact is discussed to some extent.

Keywords: Ammonoidea, Cretaceous, Cenomanian, correlation, *Graysonites*, Hokkaido, *Utaturiceras*

1. Introduction

The ammonoid genera *Utaturiceras* Wright, 1956 and *Graysonites* Young, 1958 were established nearly half century ago, and the knowledge about them is outdated. There are suitable materials in the Cretaceous areas in Hokkaido (northern Japan) and Kyushu (southwestern Japan). In this paper the material from Hokkaido is treated.

For some reasons the specimens occur in a limited part in the Teshio Mountains, northwestern Hokkaido. This part is called the Soeushinai area in accordance with the name of the official geological map of Japan, quadrangle series, 1:50,000 (Hashimoto *et al.*, 1965). The ammonoids obtained by Hashimoto *et al.* and A. Inoma during their fieldworks were in part described by Matsumoto and Inoma (1975), in which a few specimens of *Graysonites* were included.

The material of the present study is mainly the specimens which were later collected by Katsujo Yokoi, Mototaka Hayashi (who transferred his collection to K.Y.) and Yoshitaro Kawashita through their enthusiastic hunting. They provided their collections to us for paleontological study. T.M. and T.N. have been engaged in the geological field work in the Soeushinai area together with K.Y., Y.K., and other coworkers, and thus the stratigraphic positions of the obtained specimens have been determined. Regrettably K.Y. and Y.K. deceased in August 1999 and December 2000 respec-

tively, but we have continued the paleontological work on the collected specimens.

The results of our study presented in this paper are primarily concerned with the systematic paleontology. Additionally we discuss the biostratigraphic and environmental implications of the faunule.

2. Geological setting

Subsequent to the work by Hashimoto *et al.*, 1965, the Cretaceous stratigraphy of the Soeushinai area has been reinvestigated by Nishida *et al.*, with a series of progress reports (1996, 1997, 1998) in Japanese. Matsumoto and Nishida (appendix to Matsumoto *et al.*, 1999) gave a note in English about the locations of selected fossil species in the representative two route maps within this area. Meanwhile, an interesting paper from the view point of sequence stratigraphy was preliminarily set forth by Sakai (2001). It does not include paleontological information, but the subdivided lithostratigraphic units are referred to the stages and substages of the upper Albian to the Turonian on the basis of the biostratigraphic results by Nishida *et al.* (1996, 1997, 1998).

The Cretaceous strata exposed in the Soeushinai area are mainly the middle part of the Yezo Group (or Supergroup by some authors), which is accustomed to be called the Middle Yezo Subgroup (or Group by some authors), with fractions of the underlying and overly-

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ing subgroups. The Middle Yezo Subgroup in this area is lithostratigraphically subdivided into eight members, temporarily called the Members My1 to My8. On the biostratigraphic evidence the Members My1 and My2 are late Albian in age, the Members My3, My4, and My5 are early, middle and late Cenomanian, My6 and My7 are early Turonian, and My8 is middle to late Turonian, although the member boundary may be diachronous in some cases.

The ammonites described in this paper came from the Member My3. It consists of minor units of massive mudstone, mudstone with sandy laminae, and thin layered sandstone/mudstone of fine-grained turbidite facies (see Sakai, 2001). It is about 500 m in thickness, as measured on the exposure along the Hotei-zawa (Fig. 1) and in the upper reaches of the Kyoei-Sakin-zawa (Fig. 2). Ammonoids are often in the state of half ammonite preservation (for this term see Maeda, 1987), that suggests the effect of running waters. Some of them are strongly ornamented and normally preserved upto the peristome. Less ornamented ammonites, such as *Desmoceras*, *Tetragonites*, *Parajaubertella*, *Anagaudryceras*, and inoceramid bivalves are also found. In the eastern part of the Kyoei-Sakin-zawa, about 800 m to 1000 m downstream from the upper reaches, the lower part of the Member My3 crops out underneath the Miocene formation. Ammonoids are better preserved there, without showing half-ammonoid state. This suggests a tranquil condition of the sea bottom. In both areas of exposure ornamented ammonoids, such as *Graysonites* and *Mariella*, occur commonly.

Now the faunule of *Utaturiceras* - *Graysonites* is referred to the basal part of the Member My3. Even in the case of the occurrence in some fallen or transported nodules, their derivation can be judged from the basal part of My3. For some reasons the main sources of materials for the present study are in the restricted areas of the Kyoei-Sakin-zawa (Figs. 1, 2), the Hotei-zawa (Fig. 1) about 1500 m NNE of the former, and the Suribachi-zawa (Fig. 3) in the south. The Member My3 is exposed more extensively along the River Shumarinai and the Nakamata-zawa in the north. Although numerous ammonoids have been collected there, no examples of *Utaturiceras* and *Graysonites* are included. This is due to the absence of the basal part which was cut off by a fault (see Fig. 1).

The Members My3 and My2 are conformable. Since they are lithostratigraphic units, poorly fossiliferous mudstone of 50 ± 10 m thickness below the "ammonite bearing basal part" should be assigned to the lowest part of My3 in the mapped area (Fig. 2). The underlying My2 is typical turbidite facies with more interbeds of sandstone. Fragmentary or small (probably immature) specimens of mollusca occur in the upper part of My2. *Inoceramus* n. sp. A (allied to *I.*

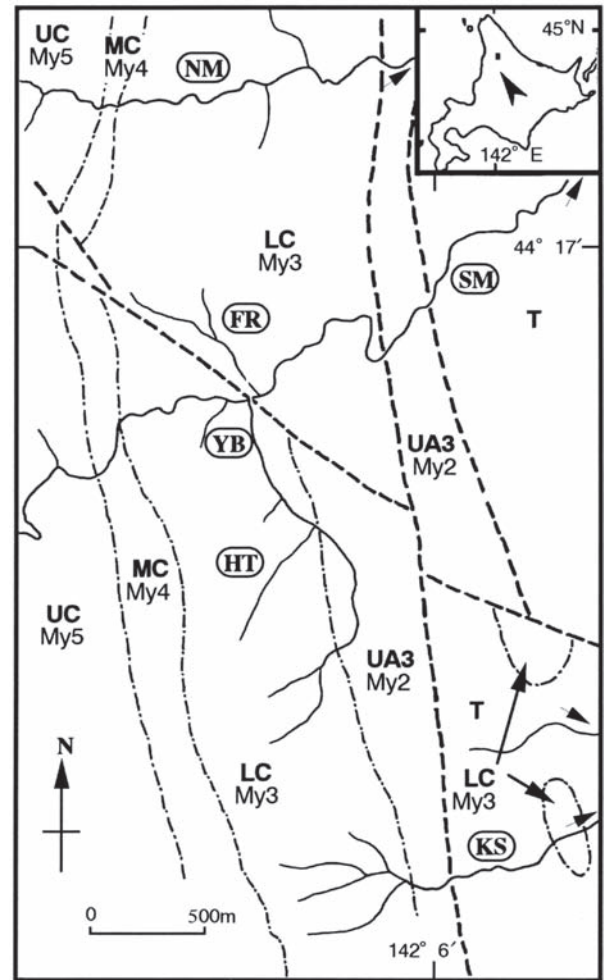


Fig. 1. Geological outline along the Nakamata-zawa (NM), Shumarinai-gawa (SM), Fukuroku-zawa (FR), Yebisu-zawa (YB), Hotei-zawa (HT), and Kyoei-Sakin-zawa (KS). Chain = boundary of members: My2 = Upper Albian (UA3), My3 = Lower Cenomanian (LC), My4 = Middle Cenomanian (MC), My5 = Upper Cenomanian (UC). T= Tertiary (Miocene). Broken line: fault. Index map of Hokkaido at upper right corner. Latitude and longitude values are referred to the Japanese Terrestrial Reference Frame.

anglicus Woods but more elongated along the axis of growth), *Bhimaites kawai* Matsumoto and Egashira, 1997 (possibly a young form of *B. stoliczkai* (Kossmat, 1898)), *Mariella (M.) bergeri* (Brongniart), *Anisoceras armatum* (Sowerby) etc. were identified by T.M., while planktonic foraminifera, *Rotalipora appenninica* (Renz) and *Ticinella primula* Luterbacher, among others, by Y. Inoue (personal communication). The above faunae altogether indicate the uppermost part of the Albian, while the lower part of My2 has yielded at Loc. R34 *Mortoniceras (Durnovarites) cf. subquadratum* (Spath), an element of the *M. (D.) perinflatum* Subzone of upper Upper Albian.

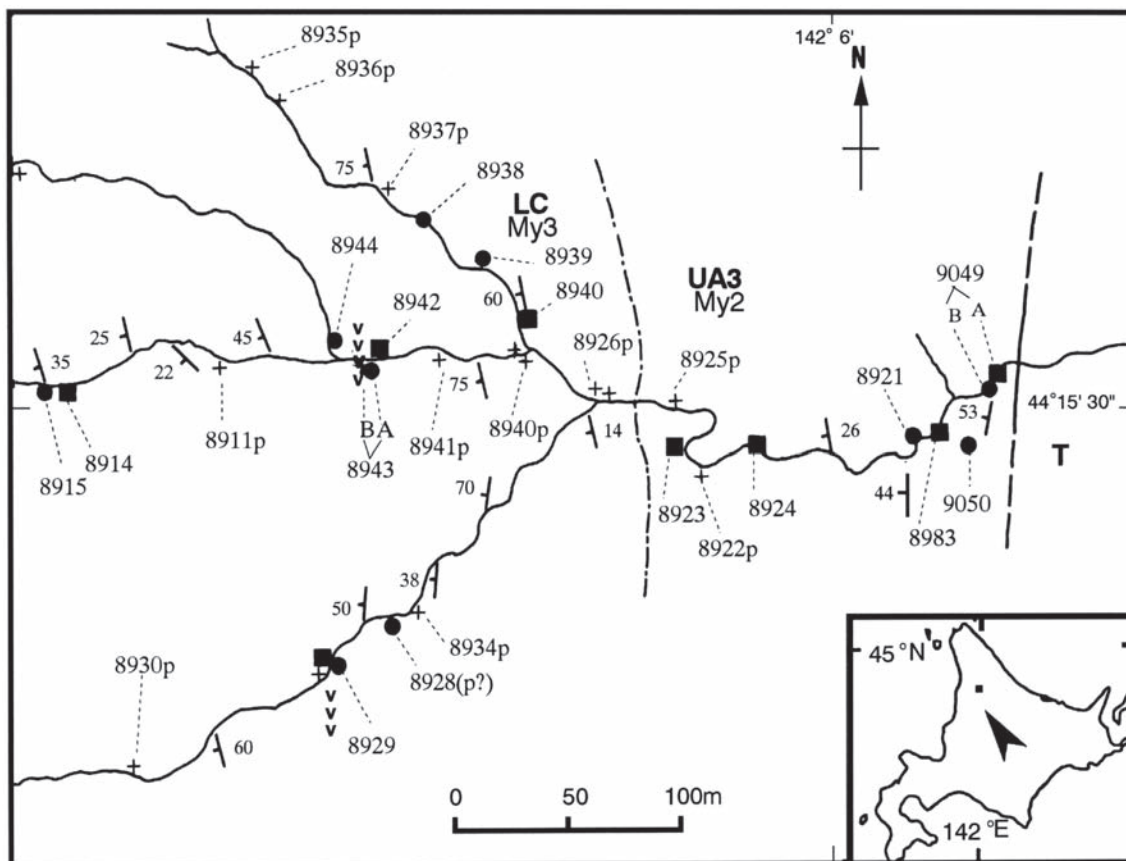


Fig. 2. Geological route map of the upper reaches of the Kyoei-Sakin-zawa. Solid circle = megafossil (in situ), cross = ditto (in fallen or transported nodule with p at the end of number), solid square = microfossil sample, v = tuff. Each number should have the prefix R. Other marks as for Fig. 1. *Utaturiceras vicinale* (Stoliczka) occurs at R8938, *Graysonites woolldridgei* at R8943A and R8928, *Inoceramus crispus* Mantell at R8930p, and so on. This map is adopted from Obradovich *et al.*, 2002, fig. 2 in p. 151 of *Proc. Japan Acad.*, vol. 78, ser. B, no. 6 by permission of the original authors and the Editor of the Academy. Latitude and longitude values are referred to the Japanese Terrestrial Reference Frame.

3. Conventions

Repositories.- The specimens treated in this paper are registered at the following institutions with abbreviated headings: GK = The Kyushu University Museum, 6-10-1 Hakozaki, Higashi-ku, Fukuoka, 812-8581; GS = Geological Collections, Faculty of Culture and Education, Saga University, 1 Honjo-machi, Saga 840-8502; TKD = Institute of Geoscience, the University of Tsukuba, 1-1-1 Tennodai, Tsukuba, 305-8571; GSJ = Geological Museum of the Geological Survey of Japan, AIST, 1-1-1 Higashi, Tsukuba 305-8567. They are all in Japan.

Subsidiary numbers.- The specimens treated in this paper were mostly collected by K. Yokoi, M. Hayashi, and Y. Kawashita (see Introduction). They had original numbers under the headings KY, H, and YKC, which were clearly indicated on the specimens and also tied up with their own locality records (H is included

in the record by K.Y.). These numbers are, therefore, useful and are indicated as subsidiary ones along with the official register numbers.

All of the YKC (Y. Kawashita's Collection), temporarily registered under GS. (Saga University) in this paper, are to be eventually kept at NSM (National Science Museum in Tokyo).

Measurements.- The following abbreviations are used mainly in the table of measurements and sometimes also in the text. M = measured position; A = apertural end; E = preserved end at some distance from A; LS = last septum (i.e., the end of phragmocone); D = diameter of shell; U = diameter of umbilicus; H = whorl height; B = whorl breadth; R+r = number of primary ribs and that of secondary ribs in the last half whorl; c = at costal position; ic = at intercostal position. It should be noted that a measured value is based on the actual specimen, even if the specimen is secondarily deformed to some extent.

4. Systematic paleontology

Class Cephalopoda
 Order Ammonoidea
 Family Acanthoceratidae Grossouvre, 1894
 Subfamily Mantelliceratinae Hyatt, 1903
 Genus *Utaturiceras* Wright, 1956

Type species.- *Ammonites vicinalis* Stoliczka, 1864

by original designation (Wright, 1956, p. 392).

Diagnosis.- Shell in maturity fairly large, with body chamber of about half a whorl. Whorls higher than broad and more or less involute. Ribs in youth gently flexuous and unequal in length; longer ones arising from bullate umbilical tubercles; shorter ones branched or intercalated; inner and outer ventrolateral tubercles on every rib, although rather weak. Adult shell ornamented by equally long ribs and weakening tubercles. Suture fairly similar to that of *Mantelliceras*, but for

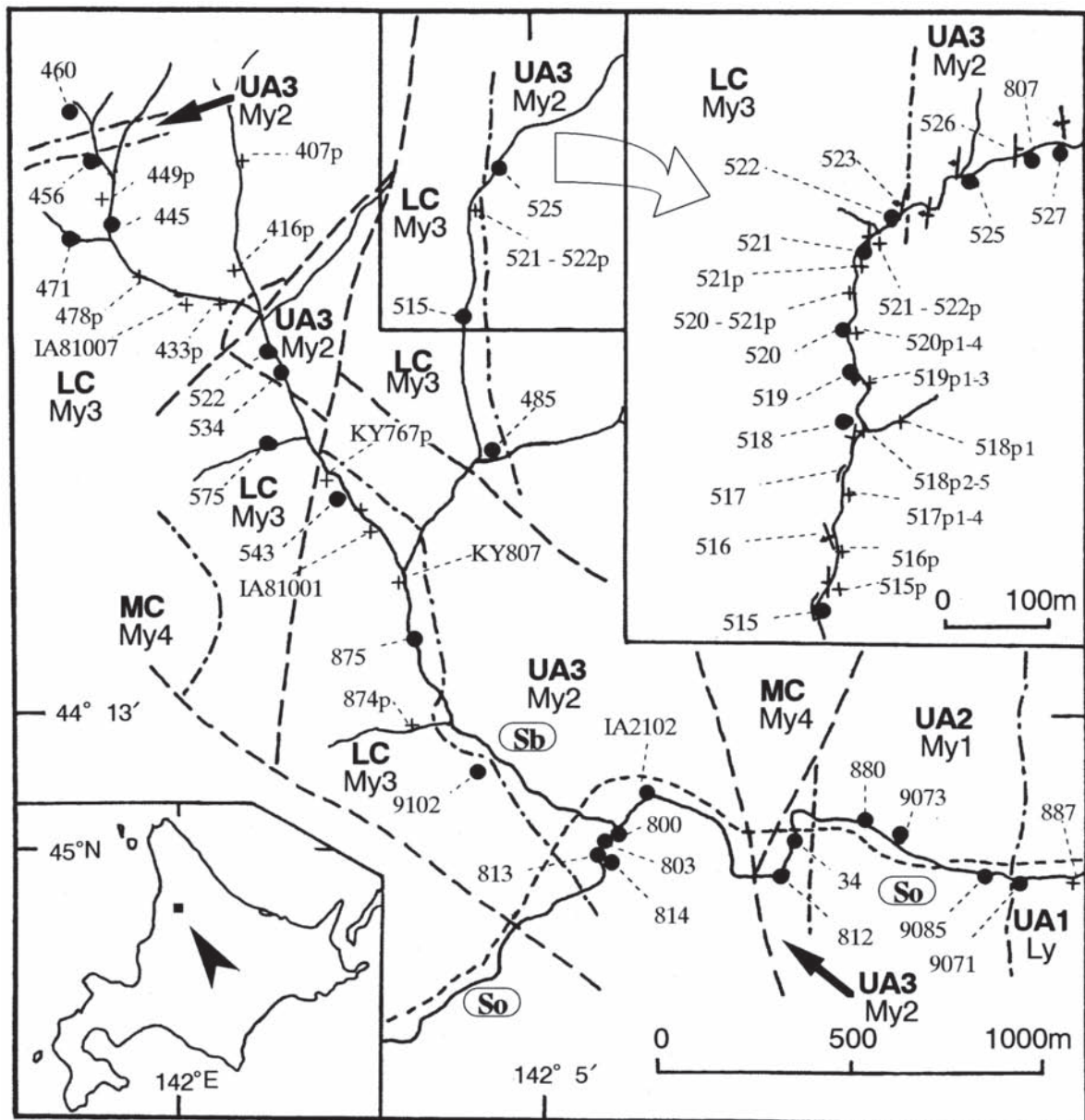


Fig. 3. Geological route map of the River Sounnai (So) and its tributary Suribachi-zawa (Sb). UA1, UA2, UA3: lower, middle and upper parts of Upper Albian; LC, MC: lower and middle parts of Cenomanian. For other marks see Figs. 1, 2. This map is modified from Matsumoto and Nishida, 2002, fig. 1 in p. 186 of *Proc. Japan Acad.*, vol. 78, ser. B, no. 7 by permission of the original authors and the Editor of the Academy. Latitude and longitude values are referred to the Japanese Terrestrial Reference Frame.

better presentation of descending auxiliary elements and somewhat phylloid terminals of folioles (e.g., Kossmat, 1895, pl. 25, fig. 2).

Discussion.- Wright and Kennedy (1996, p. 399) stated that the adult shell of this genus was unknown. Actually the body chamber of the adult shell remains partly in the lectotype of the type species. Now it is shown almost fully in some other examples. On the adult whorl ribs gradually coarsen and tubercles tend to weaken, without sign of hypernodosity.

The systematic allocation of *Utaturiceras* is not clear. At the immature stage *Utaturiceras* is similar to some late Albian species of *Neophlycticeras* or *Stoliczkaia* (*Stoliczkaia*), but *Utaturiceras* is devoid of midventral tubercles at any stage and clearly shows inner and outer ventrolateral tubercles. *U. vicinale*, the type species, and two other species described below are all larger than *Stoliczkaia* or *Neophlycticeras* at the adult stage.

The relationship between *Utaturiceras* and *Mhrhliceras* Kennedy and Wright, 1985 (with type species *Mammites lapparenti* Pervinquière, 1907) is a moot question, on which a discussion has been recently given by Matsumoto and Nishida, 2002.

Distribution.- *Utaturiceras* has been reported to occur in the lower part of the Cenomanian in South India (Stoliczka, 1864), Madagascar (Collignon, 1937, 1964), the Middle East (Lewy and Raab, 1978), southern England (Wright and Kennedy, 1996), Germany (Wiedmann and Schneider, 1979) and Japan (this paper).

***Utaturiceras vicinale* (Stoliczka, 1864)**

(Figures 4, 5)

Synonymy.-

Ammonites vicinalis Stoliczka, 1864, p. 84, pl. 44, figs. 1, 4, 5, 7, 8.

Acanthoceras vicinale (Stoliczka). Kossmat, 1895, p. 200, pl. 25, fig. 2.

Acanthoceras (Mantelliceras) vicinale (Stoliczka). Collignon, 1937, p. 64, pl. 5, figs. 3-5; Collignon, 1964, p. 148, pl. 374, fig. 1625.

Utaturiceras vicinale (Stoliczka). Wright, 1956, p. 392; Matsumoto and Sarkar, 1966, p. 297, pl. 32, fig.

1; pl. 33, figs. 1-3; text-figs. 1-4; Kennedy and Hancock, 1971, p. 445, pl. 82, fig. 3; Wiedmann and Schneider, 1979, p. 671, pl. 10, figs. 2, 5; text-fig. 10c; Wright and Kennedy, 1996, p. 399, pl. 122, fig. 1; text-fig. 156.

Lectotype.- GSI 190 (Geological Survey of India), the original of Stoliczka, 1864, p. 84, pl. 44, fig. 8, from the Utatur Group of Odium, South India, by the subsequent designation of Matsumoto and Sarkar (1966, p. 298).

Material.- GK.H8613 [= KY755] (Fig. 4), left half only preserved in a nodule of fine-grained sediments, which show banding of light and dark grey color, obtained somewhere (very point uncertain) in the Suribachi-zawa. One of the plaster casts prepared by S.T. is kept at GSJ F16090 and the other was sent to the K.Y.'s collection; GS.G270 [= YKC080615] (Fig. 5), obtained in situ at Loc. R8938, upper reaches of the Kyoei-Sakin-zawa (see Fig. 2).

Dimensions.- See Table 1.

Description.- GK.H8613 is in the state of half-ammonite preservation and only a fraction of the body chamber is shown. It is, however, quite similar to the lectotype in shell form, ornamentation and pattern of suture.

The lectotype was misunderstood by Wright and Kennedy (1996, p. 399) as immature. As Matsumoto and Sarkar (1966, p. 298) described, its last septum is at D = 117.4 mm and a part of the body chamber is preserved at least for about 60°. Judging from the trace of umbilical seam on the unillustrated right side, the adult body chamber originally occupied a half whorl (i.e., 180°). On the body chamber ribs are all long and gradually coarsen. The original diameter of this shell at the presumed end of the body chamber is approximately estimated as 175 mm.

GS.G270 is fairly large and exhibits the phragmocone plus the preserved inner flank of the body chamber, but a considerable part of the outer flank and the venter are destroyed. Its phragmocone is essentially similar to that of the lectotype and GK.H8613. It shows the right lateral view of the almost full-grown shell of this species, if the deficient part is restored. The estimated diameter would be about 195 mm. On the body chamber the primary ribs gradually coarsen, while the

Table 1. Measurements of *Utaturiceras vicinale* (Stoliczka).

Specimen	M	D	U	U/D	H	B	B/H	R + r
GSI 190	A-120°	133.0	27.7	.21	62.5	ca. 34	.54	13 + 5
GK.H8613	A-150°	120.0	30.0	.25	57.0	ca. 31	ca. .54	9 + 8
GS.G270	A	ca. 195	49.0	ca. .25	ca. 89	—	—	13 + 3
GS.G270	A-180°	ca. 125	30.0	.24	ca. 62	—	—	11 + 6

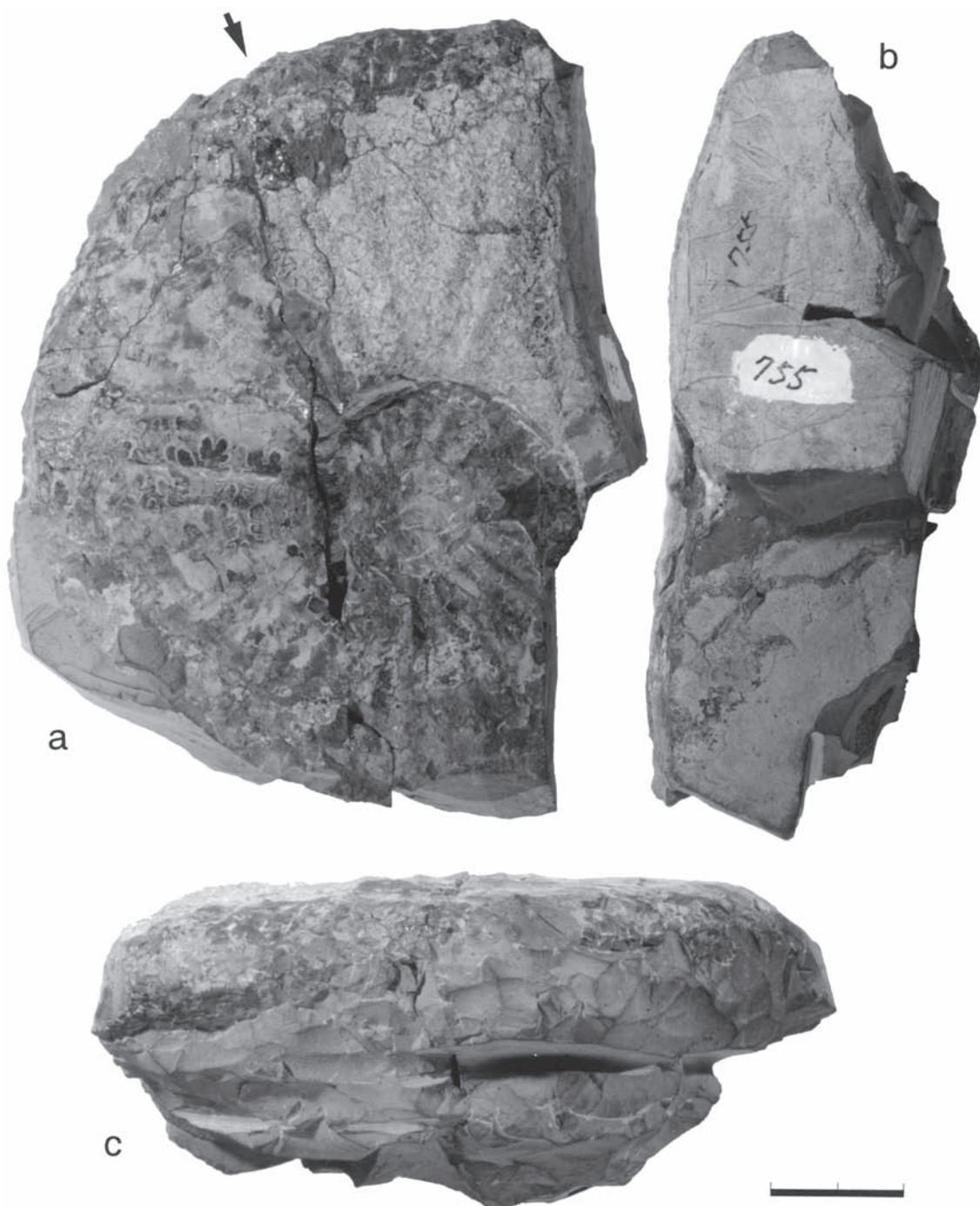


Fig. 4. *Utaturiceras vicinale* (Stoliczka).
GK.H8613 [= KY755] of half-ammonoid preservation in a transported nodule somewhere in the Suribachi-zawa (without record of the precise locality). Lateral (a), frontal (b) and back (c) views. Arrow: end of the phragmocone. Scale bar = 20 mm. Photos by S.T.

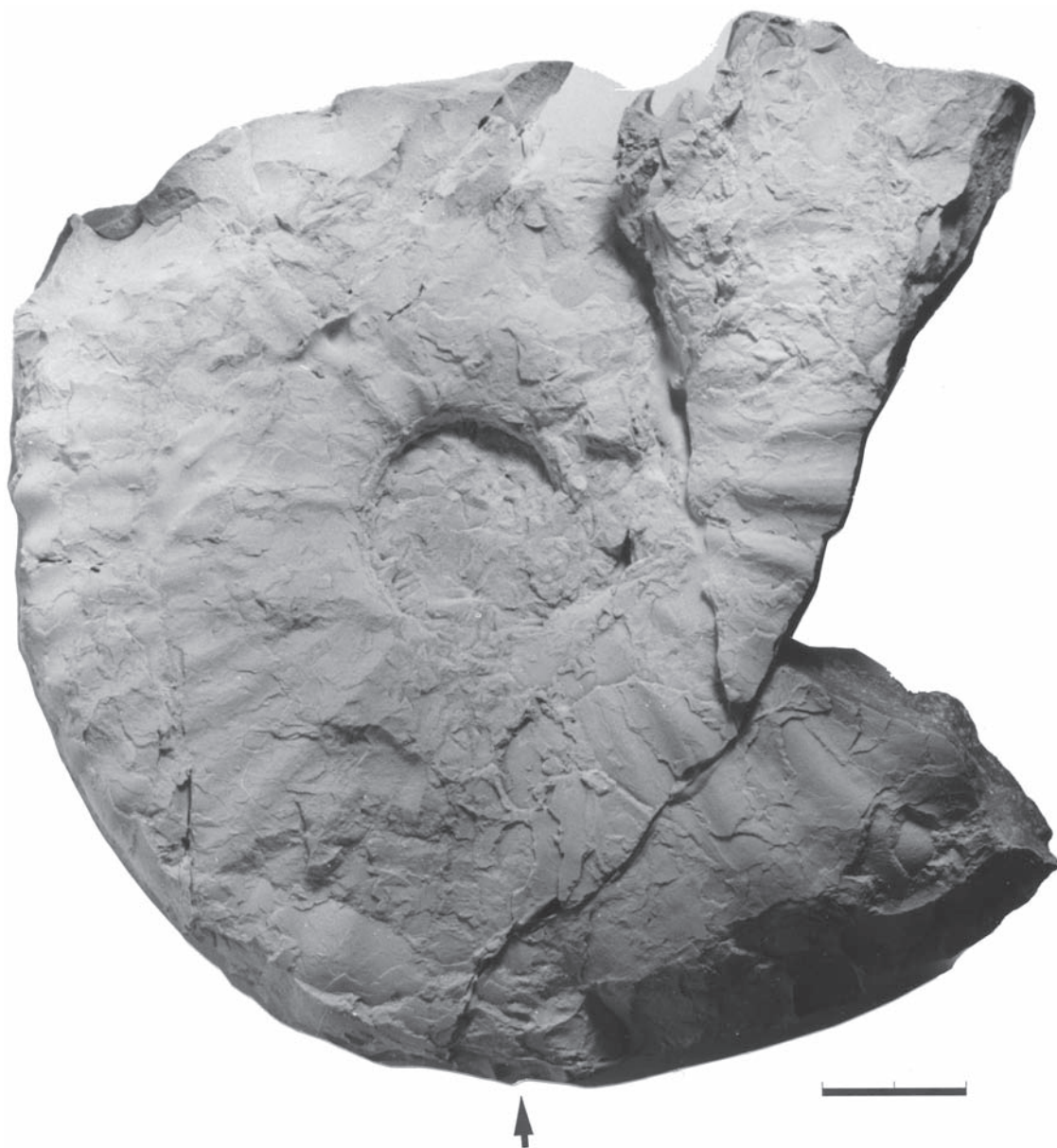


Fig. 5. *Utaturiceras vicinale* (Stoliczka).
GS.G270 [= YKC080615], lateral view of the partly broken adult specimen
from Loc. R8938, Kyoei-Sakin-zawa. Scale bar = 20 mm.
Photo by T.N.

secondaries disappear. The ventrolateral tubercles tend to weaken in the last part of the phragmocone and the succeeding part of the body chamber. In these stages the abrupt strengthening of the ribs and tubercles never occurs. In this respect this species is undoubtedly discriminated from any species of *Graysonites*.

Although we have not looked at the actual specimens, we agree with the respective authors to regard the examples of this species from Madagascar (Collignon, 1937, p. 58, pl. 7, figs. 5, 6; 1964, p. 148, pl. 374, fig. 1625), Germany (Wiedmann and Schneider, 1979, p. 671, pl. 10, figs. 2 and 5, both of which resemble a young example from S. India figured by Matsumoto and Sarkar, 1966, pl. 33, fig. 2), and south England (Wright and Kennedy, 1996, p. 399, pl. 122, fig. 1) as more or less young shells of *U. vicinale*. *U. bethlehemensis* Avnimelech and Shores (1962, p. 533, pl. 15, fig. 3; text-fig. 3) may be a secondarily compressed specimen of *U. vicinale*. Its stratigraphic allocation is revised to the *Graysonites* assemblage Zone in Israel by Lewy and Raab (1978, p. xxxi-2).

Occurrence.- This species has been reported from the lower part of the Cenomanian Stage in the scattered areas of the world. As far as Japan and Germany are concerned, it is one of the characteristic species which occur in the basal part of the Cenomanian Stage.

Utaturiceras chrysanthemum sp. nov.

(Figures 6-8)

Material.- Holotype, here designated, is GK.H8410 [= KY767](Fig. 6), collected by K. Yokoi at the point slightly upstream from Loc. R543, Suribachi-zawa (Fig. 3).

Paratype (1) is GS.G271 [= YKC040529] (Fig. 7) collected by Y. Kawashita at Loc. R8943A from the bed with *Graysonites wooldridgei*, in the upper reaches of the Kyoei-Sakin-zawa (Fig. 2). Its plaster cast is kept at GSJ F16094. Paratype (2) is GS.G272 [= YKC011011] (Fig. 8) obtained by Y.K. from a fallen nodule at Loc. R520-521p of the eastern branch of the Suribachi-zawa (see upper right corner of Fig. 3).

Diagnosis.- Shell of moderate size (D = 140~160 mm) at mature stage, with U/D = 0.24~0.27 and B/H = 0.67~0.70, showing gently convex flanks and suboval to sub-elliptical whorl section. Younger whorls some-

what compressed and ornamented by alternated long and short ribs; the long rib arises from the umbilical bullae of moderate intensity. Ribs on the adult body chamber normally long, gently flexuous, moderately strong, without or with much weakened umbilical bullae and separated by somewhat wider interspaces, except for a few narrower and approximated ones at the last portion.

Dimensions.- See Table 2.

Description.- On account of more or less incomplete preservation, the original characters of the phragmocone seem to be secondarily modified. The ribs on the septate whorls are weaker and finer than those on the adult body chamber. The bullate umbilical tubercles are fairly strong on the inner whorls. On the adult body chamber ribs strengthen gradually with growth, whereas the umbilical bullae tend to weaken and finally disappear. The inner and outer ventrolateral tubercles are recognized as clavi on the phragmocone, but they tend to be amalgamated into the outward thickened ribs on the adult body chamber, although outer ventrolateral clavi may remain on some ribs.

Comparison.- This species is distinguished from *U. vicinale* in having a less compressed body chamber which bears coarser and stronger ribs. It is fairly similar to *U. discoideale* (Kossmat), but it has a suboval rather than subtrapezoidal whorl section, more distant and broader ribs on the adult body chamber. In *U. discoideale* the inner and outer ventrolateral tubercles are distinct even on the body chamber.

Occurrence.- As for material. This species is known so far only in Hokkaido, but it could be expected elsewhere.

Utaturiceras cf. *discoideale* (Kossmat, 1895)

(Figures 9, 10)

Compared.-

Acanthoceras discoideale Kossmat, 1895, p. 201, pl. 25, fig. 1a, b, c.

Material.- GK.H8409 [= previous H43](Fig. 9), obtained by M. Hayashi at Loc. R874p, in the unnamed western branch of the lower course of the Suribachi-zawa (Fig. 3). It was transferred to K. Yokoi, who donated it to the Kyushu University Museum. One of

Table 2. Measurements of *Utaturiceras chrysanthemum* sp. nov.

Specimen	M	D	U	U/D	H	B	B/H	R + r
GK.H8410	A-30°	147.0	35.0	.24	64.0	ca. 43	ca. .67	11 + 0
GS.G271	E-30°	138.0	37.0	.27	53.0	ca. 37	ca. .70	12 + 0
GS.G272	E	160.0	40.0	.25	ca. 66	—	—	9 + 4

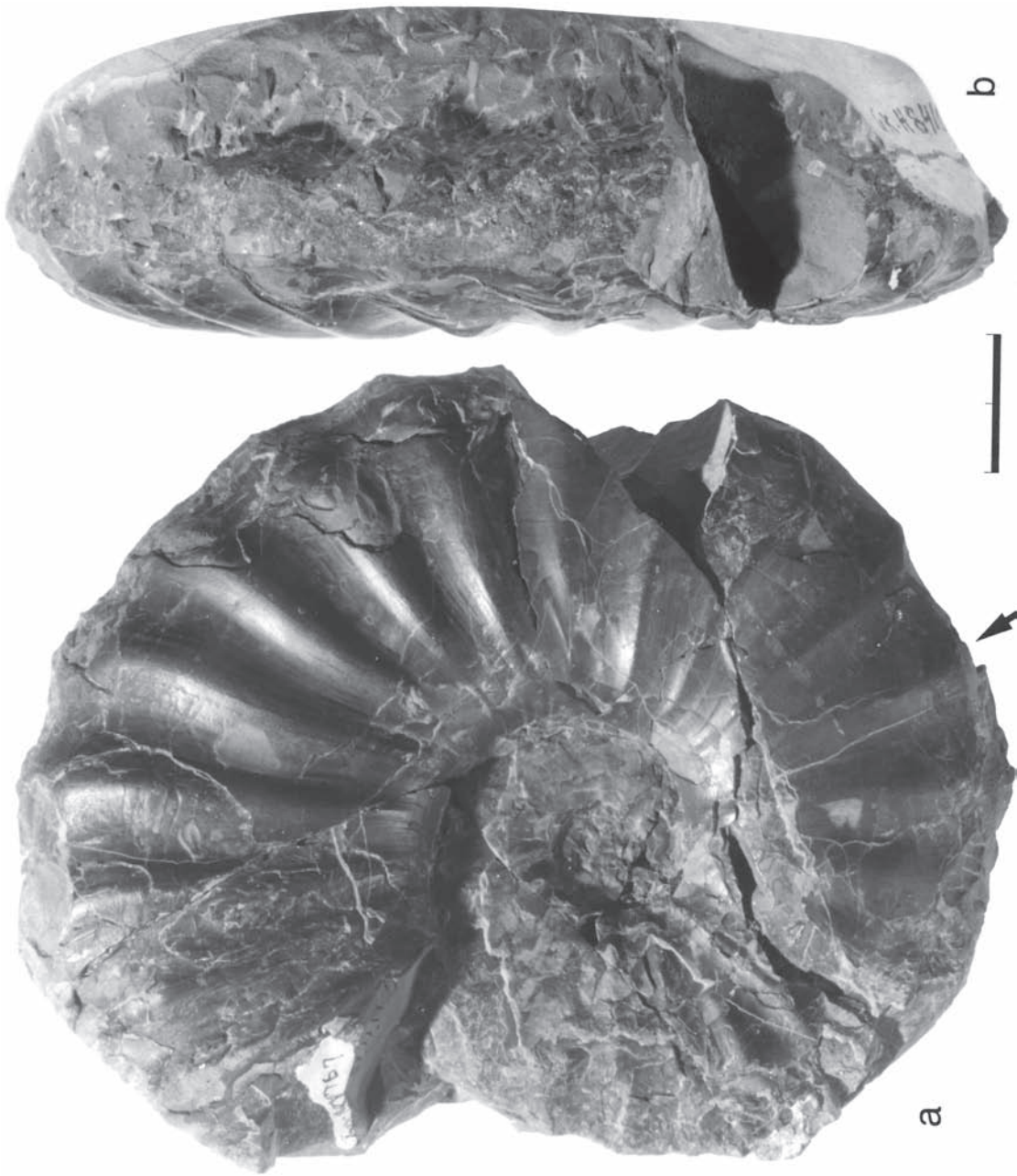


Fig. 6. *Utaturiceras chrysanthemum* sp. nov.
Holotype, GK.H8410 [= KY767]. Right lateral (a) and ventral (b) views of the adult specimen obtained from the point slightly upstream from Loc. R543 in the Suribachi-zawa. Scale bar = 20 mm.
Photos courtesy of M. Noda.



Fig. 7. *Utaturiceras chrysanthemum* sp. nov.
Paratype, GS.G271 [= YKC040529], from Loc. R8943A of the Kyoei-Sakin-zawa. Scale bar = 20 mm.
Photo courtesy of M. Noda.

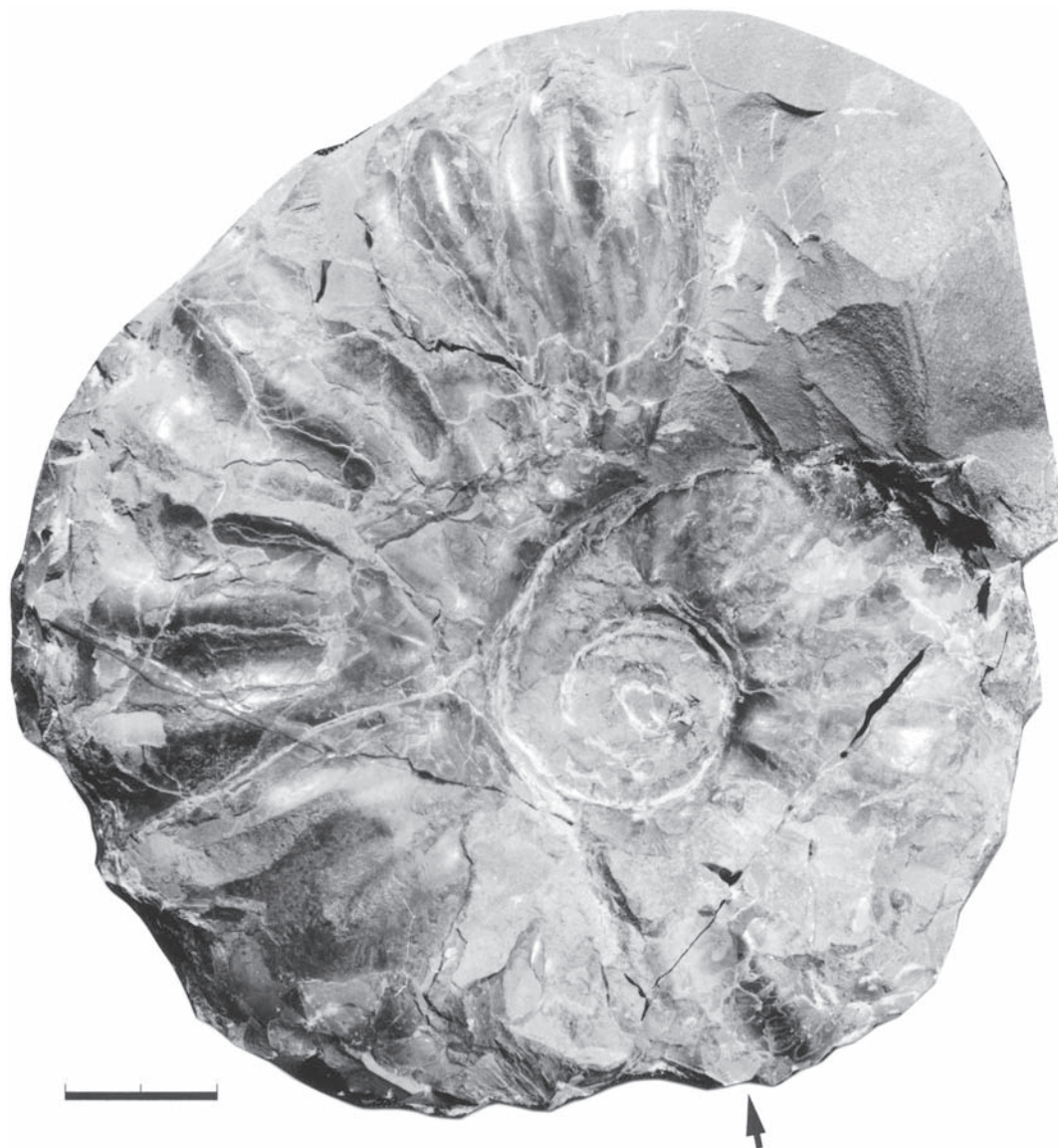


Fig. 8. *Utaturiceras chrysanthemum* sp. nov.
Paratype, GS.G272 [= YKC011011], a deformed adult specimen from Loc. R520-521p of the east branch of the Suribachizawa. Scale bar = 20 mm.
Photo courtesy of M. Noda.

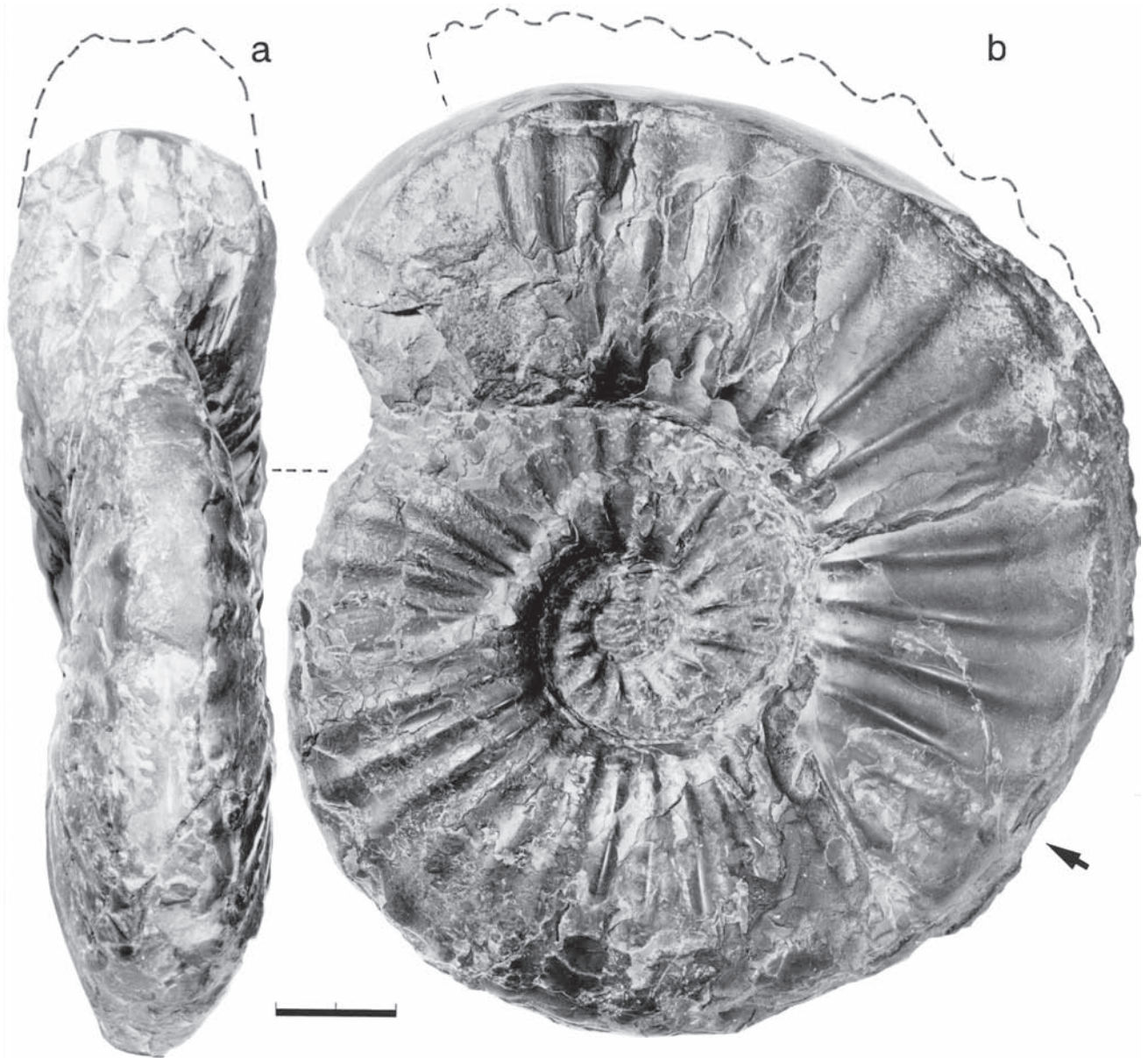


Fig. 9. *Utaturiceras* cf. *discoideale* (Kossmat).
GK.H8409 [= H43] from Loc. R874p, Suribachi-zawa. Frontal (a), right lateral (b) and left lateral (c) views. Scale bar = 20 mm. Photos courtesy of M. Noda (a, b) and by S.T. (c).



the plaster casts is kept at GSJ F14887 and the other was sent to K.Y.

Dimensions.- See Table 3.

Description.- Shell is fairly large, with D = ca. 180 mm at the restored end of the body chamber. The umbilical ratio tends to enlarge with growth (U/D from 0.27 to 0.32). In the actual specimen the body chamber is secondarily compressed and its ventral part is crushed in its posterior half and badly eroded away in its anterior half. The preserved part of the whorl is higher than broad and roughly subtrapezoidal in cross section.

Ribs are rather rectiradiate, although they may be slightly flexuous on the outer whorl. From the last part (for about 90°) of the septate part onward ribs are all long. The bullate umbilical tubercles are fairly strong on the inner whorl (see Fig. 9c), gradually weaken later and almost disappear on the body chamber. The outer ventrolateral tubercles are kept as fairly sharp clavi on the outer whorl, but the inner ones are not so distinct as those expressed by the drawing of *Acanthoceras discoidale* Kossmat (1895, pl. 25, fig. 1a, b).

Suture is observable at H = 48 mm (Fig. 10). It is quite similar to the illustration of Kossmat (1895, pl. 25, fig. 1c).

Comparison and discussion.- The holotype, by monotypy, of *Acanthoceras discoidale* Kossmat, 1895 (p. 200, pl. 25, fig. 1a, b, c), from the Middle Utatur Group of Odium, South India, should be referred to

Utaturiceras on the basis of its characters. It is not a compressed species of *Mantelliceras* nor *Sharpeiceras*, because it has no lateral tubercles at any growth stage.

The tendency to the scaphitoid uncoiling to some extent may be a general feature in many acanthoceratid ammonites. It is expressed rather remarkably in the present specimen and also in the holotype. In comparison with *U. vicinale*, these specimens have broader whorls and stronger ornamentation. Also in these specimens the long ribs begin to predominate at much earlier growth stage than in *U. vicinale* and *U. chrysanthemum*. Taking these points into consideration, the present specimen could be identified with *U. discoidale* (Kossmat). However, as its ventral part of the body chamber is secondarily crushed and partly eroded away, we prefer to call it *Utaturiceras* cf. *discoidale* (Kossmat), until better preserved specimen is obtained.

Occurrence.- The locality record of GK.H8409 suggests the derivation from somewhere in the Member My3 (lower part of the Cenomanian).

Genus *Graysonites* Young, 1958

Type species.- *Graysonites lozoi* Young, 1958 by original designation (Young, 1958, p. 171).

Diagnosis.- Whorl at early growth stage involute, compressed, and ornamented by ribs of unequal length, with inner and outer ventrolateral tubercles on every rib and bullate umbilical tubercle on long one. For a

Table 3. Measurements of *Utaturiceras discoidale* (Kossmat) and *U. cf. discoidale*.

Specimen	M	D	U	U/D	H	B	B/H	R+r
Holotype	E-50°	136.0	38.0	.28	60.0	40.0	.69	16 + 1
GK.H8409	A-30°	ca. 170	50.0	ca. .29	—	—	—	15 + 0
GK.H8409	A-90°	135.0	41.0	.30	56.0	ca. 38	ca. .68	18 + 0

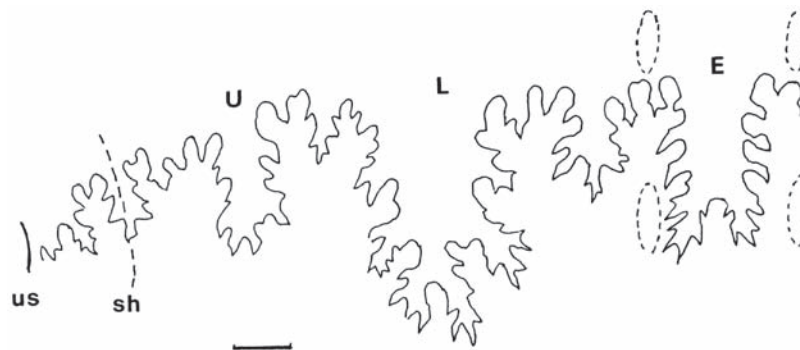


Fig. 10. *Utaturiceras* cf. *discoidale* (Kossmat).

External suture of GK.H8409 at Wh = 46 mm. Lobes are E (external), L (lateral), and U (umbilical). us: umbilical suture, sh: umbilical shoulder, dotted ellipse: outer ventral clavi. Scale bar = 5mm. Drawing by T.M.

limited period of the middle growth stage the umbilical bullae and midlateral tubercles may coexist in some cases. Later, or in other cases, the umbilical bullae may be shifted outward to the midlateral tubercles. Adult shell fairly large, with moderately wide umbilicus; body chamber of half a whorl ornamented by distant radial ribs with more or less strong midlateral nodes and prominent ventrolateral horned tubercles in the main part, but the ornament may weaken near the apertural margin. Suture essentially similar to that of *Mantelliceras*, but the phylloid aspect of the folioles is more pronounced.

Discussion.- As to the immature shell, a certain species of *Graysonites* (e.g., *G. wooldridgei*) is similar to *Utaturiceras*, but some other species resemble compressed species of *Mantelliceras*. The marked ornamentation with hypernodosity in the late growth stage is particular to *Graysonites*.

The existence of both the umbilical and midlateral tubercles in a limited part of growth in some specimens of *Graysonites* seems to foreshadow the ornamentation of *Mantelliceras*, but in the latter hypernodosity does not occur. A kind of hypernodosity appears in some species of *Sharpeiceras* (e.g., *S. kongo* Matsumoto, Muramoto and Takahashi, 1969), but the inner and outer ventrolateral tubercles are clearly discriminated throughout life in the latter.

Distribution.- *Graysonites* has been reported to occur in the lower part of the Cenomanian sequence of strata in Texas (Young, 1958), California (Matsumoto, 1959), Japan (Matsumoto, 1960; Matsumoto and Inoma, 1975; this paper), Israel (Lewy and Raab, 1978), Iran (Immel and Seyed-Emami, 1985), and Brazil (Bengtson, 1983). A poorly preserved specimen illustrated as *Graysonites* sp. from northern Spain by Wiedmann and Kauffman (1978, pl. 4, fig. 5) is doubtful, because its outer whorl does not show prominent tubercles.

In Texas the described species of *Graysonites* occur at two stratigraphic levels: *G. lozoi* Young, the type

species, in the upper subzone and others, such as *G. wooldridgei*, *G. adkinsi* and *G. fountaini* Young, in the lower subzone. Bengtson (1983) reported the occurrence of *G. lozoi* in the lower part of the Cenomanian in the Sergipe Basin of Brazil. It was not illustrated but listed together with *Sharpeiceras latyclavium* (Sharpe), *Stoliczkaia (Shumarinaia) africana* (Pervinquière), *Forbesiceras brundretti* (Young) and *Hypoturrites gravesianus* (d'Orbigny). This assemblage suggests the second subzone in the lower Cenomanian substage in reference to the zonation in Hokkaido.

***Graysonites wooldridgei* Young, 1958**

(Figures 11, 12, 13)

Synonymy.-

Graysonites wooldridgei Young, 1958, p. 175, pl. 28, figs. 1-4; pl. 29, figs. 2, 4; text-figs. 3c, d, f; Matsumoto, 1959, p. 66, pl. 18, fig. 1; text-figs. 24-27; Matsumoto and Inoma, 1975, p. 285, pl. 40, fig. 2; pl. 41, fig. 1; text-fig. 13; Lewy and Raab, 1978, table 2, pl. 1, fig. 13; Nishida *et al.*, 1996, p. 84, pl. 23, fig. 1; pl. 24, fig. 1; pl. 26, fig. 1.

Submantelliceras wooldridgei (Young). Immel and Seyed-Emami, 1985, p. 98, pl. 4, figs. 1-3.

Holotype.- UT 19819, the original of Young, 1958, p. 175, pl. 28, figs. 1-4, from the basal part of the Grayson Formation of Texas, by original designation (Young, 1958, p. 171).

Material.- GS.G234 [= YKC010618](Fig. 11), collected by Y. Kawashita *in situ* from a bed at Loc. R8943A in the upper reaches of the Kyoei-Sakin-zawa. GS.G236 [= YKC040808](Fig. 12) in a nodule (fallen?) at Loc. R8928(p?), about 120 m southward from R8943A (see Fig. 2). GK.H8420 [= H25] (Fig. 13), obtained by M. Hayashi somewhere in the Kyoei-Sakin-zawa. It was transferred from M.H. to K.Y. One of the plaster casts is kept at GSJ F16093 and the other

Table 4. Measurements of *Graysonites wooldridgei* Young.

Specimen	M	D	U	U/D	H	B	B/H	R + r
UT 19819	LS + 30°	125.0	26.5	.21	45.0	26.5	.59	6 + 6
GK.H8420	A - 15° (ic)	192.5	59.0	.30	74.0	51.0	.68	8 + 1
//	LS + 10° (ic)	142.0	34.0	.25	66.0	44.0	.67	—
//	A -360°	84.0	18.0	.21	44.0	32.0	.72	5 + 8
GS.G234	E(A - 120°)	162.0	47.0	.29	67.0	—	—	8 + 4
//	LS(E - 60°)	148.0	41.0	.28	63.0	—	—	9 + 5
GS.G236	A - 30°	185.0	67.0	.36	60.0	—	—	6 + 1
//	A - 180°	142.0	42.0	.30	57.0	—	—	7 + 5
TKD.30595	E(A - 10°)	184.0	52.0	.28	71.5	42.0	.59	8 + 1



Fig. 11. *Graysonites wooldridgei* Young.
GS.G234 [= YKC010618] from Loc. R8943A, Kyoei-Sakin-zawa. Two lateral views (a, b) under different lighting. Scale bar = 20 mm.
a: reproduced from Nishida *et al.*, 1996, pl. 24 by permission of the Editor; b: courtesy of M. Noda.



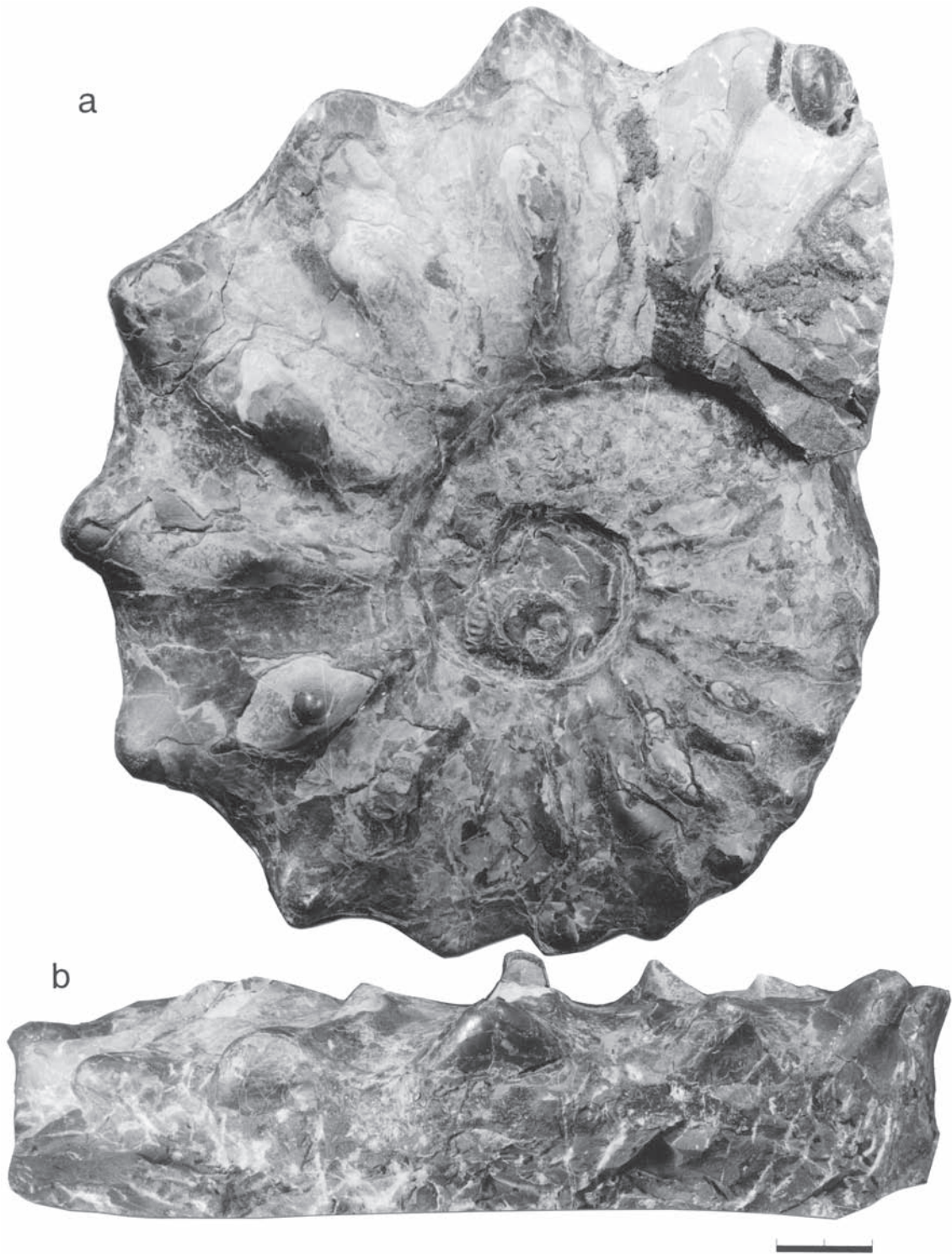


Fig. 12. *Graysonites wooldridgei* Young.
GS.G236 [= YKC040808] from Loc. R8928p, Kyoei-Sakin-zawa. Lateral (a) and ventral (b) views. Scale bar = 20 mm.
Photos courtesy of M. Noda; reproduced from Nishida *et al.*, 1996, pl. 25 by permission of the Editor.

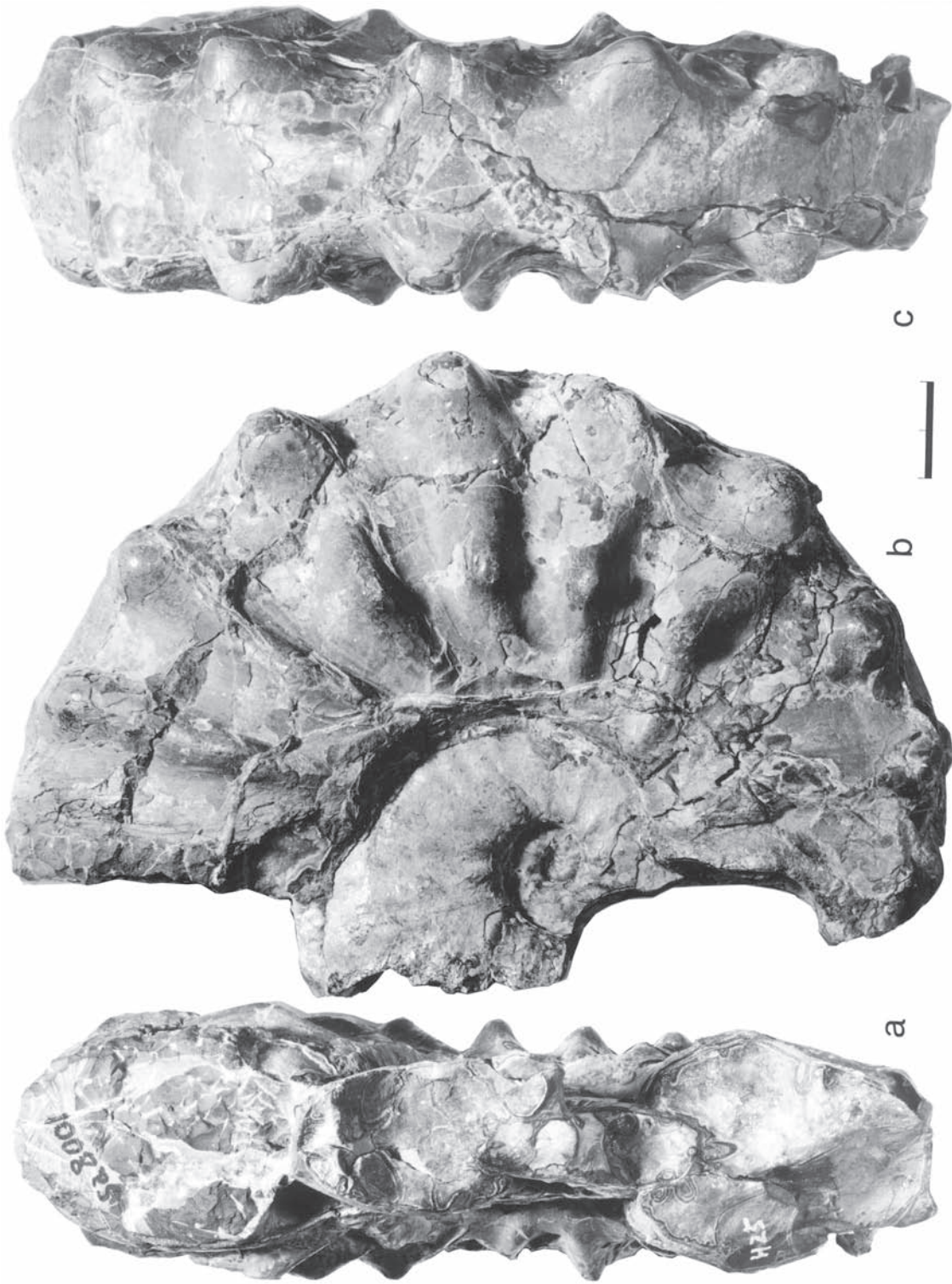


Fig. 13. *Grapsosites woolldridgei* Young.

GK.H8420 [= H25] from the Kyoei-Sakin-zawa. Frontal (a), right lateral (b) and ventral (c) views. Scale bar = 20 mm.

Photos courtesy of M. Noda (a, b); reproduced from Nishida *et al.*, 1996, pl. 23 by permission of the Editor, and by S.T. (c).

was sent to K.Y.

Also TKD.30595, obtained by Saburo Kanno at Loc. 30z in the middle course of the Kyoei-Sakin-zawa, about 1000 m east of R8943, and described previously (Matsumoto and Inoma, 1975, p. 285, pl. 40, fig. 2; pl. 41, fig. 1). GK.H8518, collected by Y. Kawashita at Loc. Y537-538p in the Tengu-zawa of the Shuparo Valley (mentioned by Matsumoto and Nishida, 2000, p. 6).

Dimensions.- See Table 4.

Description.- Immature shell is compressed, fairly involute, and ornamented rather densely with gently flexuous ribs of unequal length, of which shorter ones are branched from, or intercalated between, the longer ones; every rib bears inner and outer ventrolateral nodes, of which the outer one is distinctly clavate; long rib arises from the umbilical bulla. This ornamentation of immature pattern continues for fairly long period.

In a rather late part of the septate stage more or less weak midlateral bullae may occur in some individuals for variable duration in addition to the distinct tubercles at the umbilical edge. In others the umbilical bullae tend to shift outward with increasing strength to the midflank.

On the adult body chamber ribs are all long, widely separated, rectiradiate, rigid and provided with fairly strong midlateral tubercles and still larger ventrolateral protuberances which are developed from the united inner and outer ventrolateral tubercles of the septate stage. The ornament is most prominent on the middle part of the adult body chamber of half a whorl.

The last portion of the body chamber tend to be evolute and decreases in height. One or two ribs near the peristome are weakened, narrowed and somewhat approximated.

Remarks.- Holotype of this species is almost wholly septate and only a posterior part (about 30°) of the adult body chamber is preserved. TKD.30595, GK.H8420 and GS.G236, from Hokkaido, show more clearly the change of characters with growth, although there may be some difference between individuals in detail.

Discussion.- The young shell of this species is fairly similar to that of *Utaturiceras vicinale*. This may suggest a common or closely related origin between them. While the characters change gradually with growth in *U. vicinale*, the strong ornamentation of *Graysonites* fashion occurs rather abruptly in the adult whorl of *G. wooldridgei*. The hypernodosity occurs in this species somewhat later and is not so exaggerated as in other species of *Graysonites*. However, contrary to the opinion by Immel and Seyed-Emami (1985, p. 98), there is no sufficient reason to exclude this species from the genus *Graysonites*.

The size of the shell at the full-grown stage is about 200 mm in the examples from Hokkaido. A specimen

from California is as large as 284 mm (Matsumoto, 1959, p. 66). However, the available material is not sufficient to discuss the size dimorphs.

Occurrence.- This species occurs in the basal part of the Member My3 of the Soeushinai area of the Teshio Mountains and rarely in the correlatable unit of the Yubari Mountains. It characterizes the assemblage zone in the basal part of the Cenomanian Stage (for more details, see Chapter 5, p. 155). In Texas it is an element in the Zone of *Graysonites adkinsi* (see Young, 1958, p. 176). As to the occurrence in California there is a record by Matsumoto (1959, p. 71) on the basis of M. V. Kirk's field work.

Graysonites adkinsi Young, 1958

(Figures 14, 15)

Synonymy.-

Graysonites adkinsi Young, 1958, p. 176, pl. 29, figs. 1, 7; text-figs. 2a, e, f; 3a, e; Nishida *et al.*, 1996, p. 86 (listed), pl. 18, fig. 1; pl. 19, fig. 1; pl. 20, fig. 1; pl. 21, fig. 1; pl. 22, fig. 1; pl. 25, fig. 1; pl. 28, fig. 1; pl. 29, fig. 4.

Graysonites n. sp., Young, 1958, pl. 28, figs. 5, 6; text-fig. 2d.

Holotype.- UT 272, the original of Young, 1958, p. 176, pl. 29, figs. 1, 7, from the top of the Main Street Limestone, Texas, by original designation (Young, 1958, p. 176).

Material.- GS.G232 [= YKC060918] (Nishida *et al.*, 1996, p. 96, pls. 18-20) collected by Y. Kawashita from the vicinity of Loc. 30z; GS.G231A [= YKC030728A] and GS.G231B [= YKC030728B] (Ditto, 1996, p. 96, pl. 29, fig. 4) collected by Y.K. at Loc. R575 in the western branch of the middle course of the Suribachi-zawa; GS.G233 [= YKC630820] (Ditto, 1996, p. 96, pl. 21, fig. 1) collected by Y.K. at Loc. R420 (*in situ*) in the upper reaches of the Suribachi-zawa; GS.G235 [= YKC030514B] (Ditto, p. 96, pl. 25, fig. 1) collected by Y.K. at Loc. R520p, eastern branch of the Suribachi-zawa; GS.G237 [= YKC010930] (Ditto, pl. 27, fig. 1) collected by Y.K. at Loc. R515 (*in situ*), eastern branch of the Suribachi-zawa; GS.G293 collected by Nishida and others at Loc. R8408p, Yoshitaro-zawa, a southern branch in the upper reaches of the Sanjussen-zawa; GS.G294 [= YKC030516] collected by Y.K. at Loc. R8809p in the middle course of the Aino-sawa, a southern branch in the middle course of the Sanjussen-zawa; TKD.30169 (Matsumoto and Inoma, 1975, p. 287, pl. 41, fig. 2) collected by A. Inoma and W. Hashimoto at Loc. 72907p of the Sanjussen-zawa; TKD.30170 (Ditto, p. 287, pl. 42, fig. 1) collected by A.I. at Loc. 81003p of the Suribachi-zawa; GK.H8418 [= H17] (Figs. 14, 15) (also Nishida *et al.*, 1996, pl. 22, fig. 1) obtained by M. Hayashi somewhere in the Kyoei-

Table 5. Measurements of *Graysonites adkinsi* Young.

Specimen	M	D	U	U/D	H	B	B/H	R + r
UT 272	E	120.0	27.5	.23	44.0	27.5	.63	7 + 2
GK.H8418	A(ic)	207.0	72.0	.35	70.0	49.0	.70	7 + 0
//	A - 30° (c)	195.0	64.0	.33	72.0	70.0	.95	7 + 0
//	A - 100° (ic)	171.0	55.0	.37	64.0	56.0	.78	7 + 0
//	A - 180° (c)	135.0	34.0	.25	61.0	50.0	.82	7 + 0
GS.G232	A - 30°	217.0	66.0	.30	83.0	48.0	.52	8 + 0
//	A - 60° (ic)	177.0	57.0	.32	77.0	37.0	.48	7 + 1
GS.G235A	A - 30°	233.0	82.0	.35	—	—	—	8 + 0

Sakin-zawa and later transferred to K. Yokoi, who donated it to the Kyushu University Museum. One of the plaster casts of GK.H8418 is kept at GSJ F16092 and the other was sent to K.Y. KY356 (to be officially registered at the Nakagawa Museum of Natural History, Teshio-nakagawa, northern Hokkaido) (Nishida *et al.*, 1996, pl. 28, fig. 1) collected by K. Yokoi in the vicinity of Loc. 30z in the middle course of the Kyoei-Sakin-zawa.

Dimensions.- See Table 5.

Description.- Fairly numerous specimens from the lower Cenomanian strata of the Soeushinai area show some extent of variation and are dissimilar in the mode of preservation. The characters described below depends primarily on the better preserved examples (e.g., GK.H8418).

On the inner whorl long and short ribs are alternated with moderate intervals; the umbilical bulla on the long rib is considerably shifted outward toward the midflank. The inner and outer ventrolateral tubercles are concealed by the outer whorl. At this stage ribs are rather weak but the umbilical tubercles are moderately strong and bullate.

The late part of the phragmocone, for about half of the last whorl, is comparatively thick (e.g., B/H = 0.86) and ornamented at regular intervals (at each 25°~ 30°) by rectiradiate ribs, each of which has a tubercle at midflank, and inner and outer ventrolateral tubercles that rest on a common elevation.

The body chamber of the adult stage occupies half a whorl and shows moderate umbilical ratio (e.g., U/D = 0.33), although at the last substage the whorl tends to be evolute and the umbilicus is slightly enlarged. The ribs and tubercles both strengthen and the inner and outer ventrolateral tubercles are united into a broad and thick horn which stretches obliquely outward. At the last stage the ornament is reduced and the aperture is simple in outline (see Figs. 14, 15).

Remarks.- Concerning the specimens listed above,

the variation in size is not great. The diameter of the shell is 205 mm at the apertural end of GK.H8418. In another specimen (KY356) it is 220 mm at the peristome and 230 mm in the costal section. GS.G233, with D = 270 mm along the costae, may be the largest example, although it is somewhat distorted.

Ribs are typically rectiradiate, but in a few specimens some of the ribs are slightly flexiradiate.

In the shell of later growth stages the midlateral bullae are definite, while the umbilical bullae are absent or completely shifted to the midflank. However, in some specimens umbilical nodes are bullate as long as inner half of the flank, or two culminations, weaker one at the umbilical shoulder and more distinct one at about the midflank, are discernible on some ribs of the late growth stage (e.g., GS.G232; Nishida *et al.*, 1996, pl. 19, fig. 1). Similar features are shown in the specimens from Texas (Young, 1958, pl. 28, fig. 6; pl. 29, fig. 1).

Discussion.- Holotype from Texas is almost wholly septate, and the characters of the main part of the adult body chamber is not shown. Furthermore, it is secondarily compressed, showing B/H = 0.64. The whorl section of another specimen (Young, 1958, text-fig. 2a) is less distorted. In this respect the specimens from Hokkaido are rather similar to the latter specimen, i.e., W. S. Adkins Collection no.3043a, in which, however, the late part with diameter over 125 mm is lacking. The holotype and another specimen of *G. adkinsi* from Texas are thus incomplete, but the characters described by Young (1958, p. 177) essentially match with those observed in the specimens from Hokkaido up to a certain late growth stage. We conclude, therefore, the specific identity between the material of Texas and that of Hokkaido. The characters described in this paper on the specimens from Hokkaido can, thus, improve the previous notion of *G. adkinsi* in showing the less distorted shape with better preserved ornaments up to the end of the full grown shell. The whorl sections

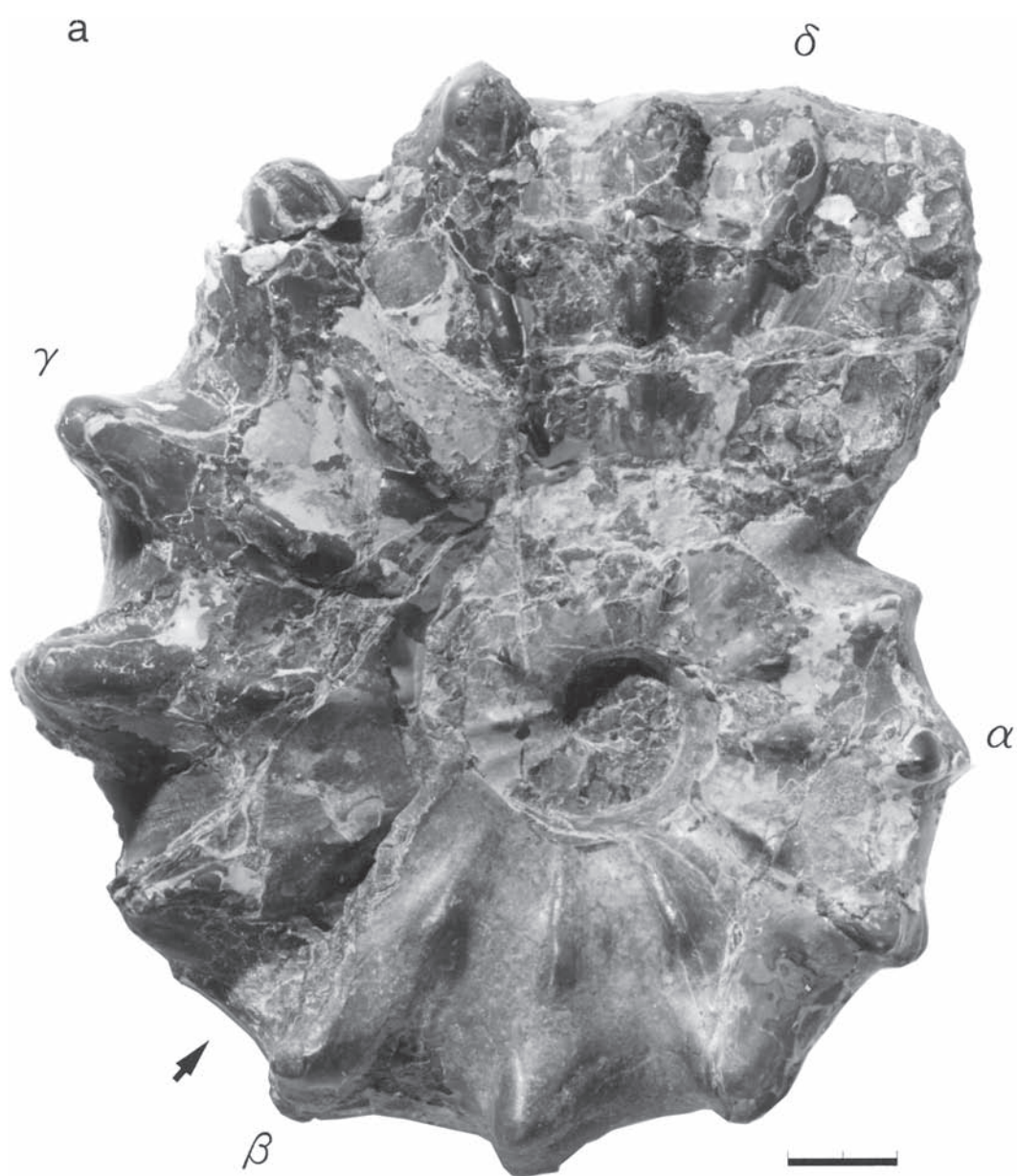


Fig. 14. *Graysonites adkinsi* Young.
GK.H8418 [= H17] from the Kyoei-Sakin-zawa. Left lateral (a),
frontal (b), ventral (c), right lateral (d) and another ventral (e) views.
Scale bar = 20 mm. α , β , γ , δ : positions of the whorl sections in Fig.
15. Photos d, e reproduced from Nishida *et al.*, 1996, pl. 22 by
permission of the Editor; a-c by S.T.



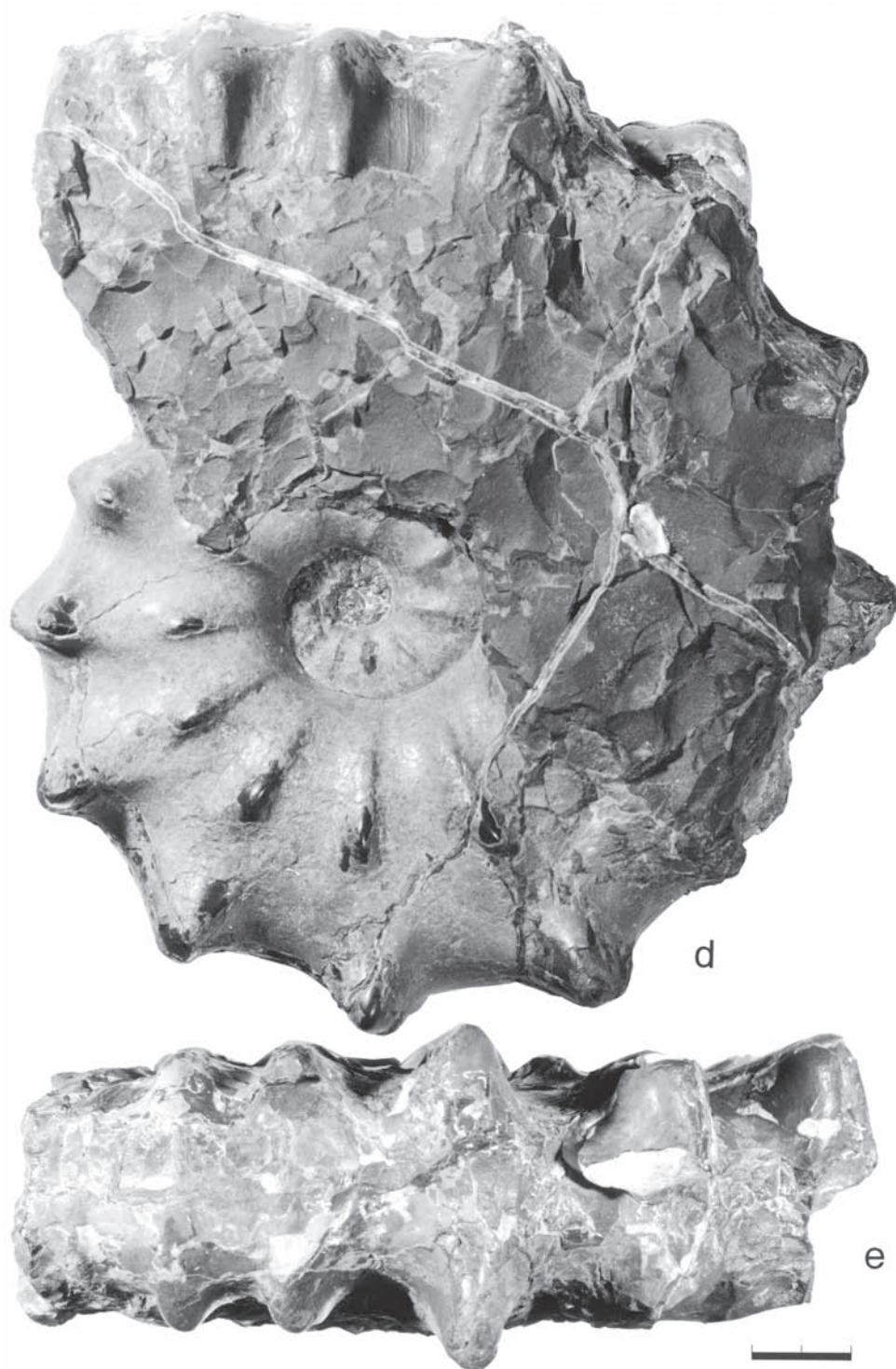


Fig. 14. *Graysonites adkinsi* Young. (continued)

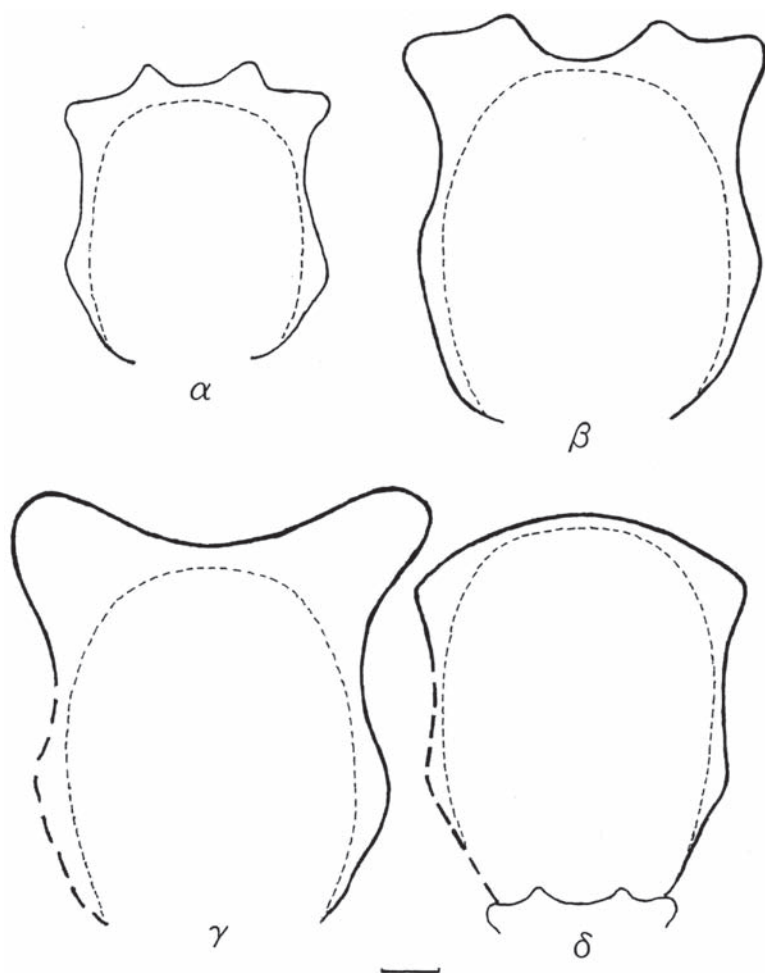


Fig. 15. Diagram showing the costal whorl sections of GK.H8418 (*Graysonites adkinsi* Young) at selected stages of growth. α : at about the beginning of the last whorl; β : at the end of the phragmocone, 180° prior to the apertural end; γ : at the middle of the body chamber; δ : along the weakened last rib, about 15° prior to the apertural end. Dotted line: intercostal section. Scale bar = 10 mm. Drawing by T.M.

shown in Fig. 15 also supplement those of Young (1958, text-fig. 2a). Moreover, *Graysonites* n. sp. by Young (1958, pl. 28, figs. 5, 6; text-fig. 2d) is probably within the variation of *G. adkinsi*, if we consider the remarks written above.

Occurrence.— Fairly numerous specimens occur in the lower part of the Member My3 (lower Cenomanian) of the Soeushinai area, southern part of the Teshio Mountains, NW Hokkaido. They form an assemblage zone together with *G. wooldridgei*, *Utaturiceras vicinale*, *U. chrysanthemum* and *Mrhiliceras lapparenti* (Pervinquièrè) (see Matsumoto and Nishida, 2002 for the last species), which represents the basal part of the Cenomanian Stage. In Texas this species is the zonal index of the basal Cenomanian. In Israel it represents the lowest zone of the Cenomanian Stage (Lewy and Raab, 1978). It is also reported from Iran (Immel and Seyed-Emami, 1985).

5. Further notes

(Biostratigraphic and environmental implications)

Previously the ammonoid species belonging to the genera *Utaturiceras* and *Graysonites* have not been necessarily evaluated from the viewpoint of biostratigraphic zonation and the interregional correlation. This is due to their absence or scarce occurrence in Europe and also some ambiguity in the type areas. The recent researches in Japan, including the results of the present study, would improve the previous situation. It is now clear that the *Graysonites* - *Utaturiceras* bearing zone is allocated to the basal part of the Member My3 and is succeeded by another ammonoid zone which is defined by the assemblage *Stoliczkaia (Lamnayella) sanctaecatherinae* Wright and Kennedy, *S. (L.) amanoi* Matsumoto and Inoma, *Mariella (M.) dorsetensis* (Spath), *M. (M.) gallienii* (Boule, Lemoine and Thévenin) and *M. (M.) oehlerti* (Pervinquièrè) etc. A small form of *M. (M.) oehlerti* begins to occur in the basal zone together with *G. adkinsi*. Moreover, an adult specimens of *Mrhiliceras lapparenti* (Pervinquièrè, 1907) has been recently recognized from the zone with *G. adkinsi* (Matsumoto and Nishida, 2002). The second zone is succeeded above by the *Mantelliceras saxbii* bearing zonule.

As has been recently reported by Obradovich *et al.*, 2002, ^{40}Ar - ^{39}Ar total fusion ages on sanidine from tuffs from the first zone and the third zonule are respectively 99.16 ± 0.37 Ma and 98.98 ± 0.38 Ma. A sample of foraminifera from Loc. R8942, slightly below R8943A (a bed with *G. wooldridgei* and *U. chrysanthemum*) and R8943B (original bed of tuff sample), contains *Rotalipora grobotruncanoides* (Sigal), an important foraminifer species whose first appearance is regarded as a criterion to recognize the base of the Cenomanian Stage (see Tröger and Kennedy in Rawson *et al.*, ed., 1996, p. 57-68). Although there is some thickness of strata without index species between the first zone (Zone with *G. wooldridgei*, *U. chrysanthemum* and *U. vicinale*) and the fossiliferous part of the underlying Member My2, Obradovich *et al.* (2002) stated that the Albian/Cenomanian boundary will be at least as old as 99.2 ± 0.4 Ma.

Despite the importance as the age indicator, fossils of *Graysonites* and/or *Utaturiceras* are found in the restricted areas in Japan, i.e., the Soeushinai area of NW Hokkaido and the islands of Goshonoura and Shishi-jima off the coast of SW Kyushu, about 1700 km apart from each other. In addition we know rare occurrences of poorly preserved fossils which can be referred to *Utaturiceras* and/or *Graysonites* in the basal part of the Cenomanian Stage in the Mikasa district and the Shuparo Valley of central Hokkaido.

In the global scale the two genera are known to occur in much separated regions, and they are not necessarily associated with each other. *Utaturiceras* has been recently reported to occur in Germany, England and Israel in addition to S. India, Madagascar and Japan, whereas *Graysonites* has been recorded from Texas, California, Japan, Israel, Iran and eastern Brazil.

The above records suggest that these ammonoids may have scattered extensively at their planktonic larval and/or early immature stages and that their life at the mature stage may have been ecologically and/or environmentally restricted. What kind of environment did the two genera preferred respectively is a problem to be scrutinized further.

Judging from the rigid ribbing and hypernodosity of the body chamber, *Graysonites* may have been a bottom dweller at the adult stage, although it may have swum or floated occasionally. The ribs and tubercles are most prominent in the middle part of the adult body chamber, so that the living shell may be settled firmly onto the bottom sediments. *Utaturiceras*, characterized by a rather narrow shell with gently flexuous ribs and less prominent tubercles, may have been a better swimmer, although it may have rested on the bottom sediments from time to time.

How deep was the sea bottom where shells of the two genera were embedded? In the case of the Soeushinai area, we can refer to the sedimentological

features. The lower Cenomanian Member My3 conformably overlies the upper Albian Member My2. The main part of the latter consists of alternated sandstone and mudstone of typical turbidite facies. The Member My3 is made up of minor unit of massive mudstone and that of thin layered or laminated mudstone and sandstone, the latter of which may be called sediments of fine-grained turbidites. The remains of *G. wooldridgei*, *G. adkinsi*, *Mrhiliceras lapparenti*, *U. vicinale*, *U. chrysanthemum*, *U. cf. discoidale* and small forms of *Mariella oehlerti* are embedded in the above mentioned minor units of both facies in the lower part of the Member My3. In the case of the fine-grained turbidites, fossils of these ammonoids show the style of "half ammonite preservation" (defined by Maeda, 1987), that indicates some effect of running waters.

Fossil bivalves from several localities of the Member My3 were sent to Masayuki Tashiro, who preliminarily informed us that the fauna is characterized by the assemblage of *Solemya* [= *S. (Achalax)* by some authors], *Thyasira* [=? *Conchocela* by some authors of Cenozoic fauna], and *Thracia*, *Periplomya* (*Offadesma*) and *Myrtea*. This assemblage indicates, according to Tashiro, a somewhat deep environment, such as a lower belt of the shelf sea or an upper part of the submarine slope. [More details are to be published by M. Tashiro.] In fact, *Paleodictyon* was detected by T. Sakai, T.N. and T.M. in the sediments of fine-grained turbidites in the lower part of the Member My3 at Loc. R9004A of the Shumarinai River route. This point is about 10 m below R9004B, where *Stoliczkaia (Lamnayella) amanoi* Matsumoto and Inoma was obtained.

In the case of the material from Soeushinai, the specimens of *Graysonites* and *Utaturiceras* are mostly preserved up to the peristome of the adult stage. An example of *Mrhiliceras lapparenti* is also adult (see Matsumoto and Nishida, 2002). They must have been transported from their original habitat for some unknown distance without damage. In other words, *Graysonites* and probably also *Utaturiceras* and *Mrhiliceras* may have lived at their adult stage in somewhat deeper part of the shelf sea in comparison with many acanthoceratids in shallower part, although the actual depth is hardly estimated. Adult *Utaturiceras* may have been a better swimmer.

The above problem about the habitat of *Graysonites* and *Utaturiceras* must be concerned with the absence or rare occurrence of these guide ammonites in the basal part of the Cenomanian sequence of sediments in western Europe. The sedimentary environment at the beginning of the Cenomanian Age in that region may have been too shallow for this group of ammonoids. The rare occurrence of the incomplete or immature shells of *Utaturiceras* indicates the distribution of this genus in western Europe, but *Graysonites*

has not been confirmed, except for a doubtful record in Spain (Wiedmann and Kauffman, 1978). The reason of the absence of *Graysonites* in Europe may be paleogeographic. In fact this genus is distributed extensively in the Cretaceous “Tethys-Pacific” realm. It has not been, however, reported from South India, Madagascar and South Africa. These areas may have formed a particular region in the mid-Cretaceous time. Namely this region was under the condition of break-up continent, it may not have been afforded by a submarine environment suitable for *Graysonites* to live. As to Madagascar Wright and Kennedy (1981, p. 79) noted that certain very small specimens, which were erroneously referred to *Mammites* by previous authors, may be juveniles of the “group of *Graysonites* and *Sharpeiceras*”. However, without looking at better preserved specimens, we hesitate to approve the occurrence of *Graysonites* in Madagascar.

In the islands of Shishijima and Goshonoura, off the coast of southwestern Kyushu, several specimens of *Graysonites* have been already described paleontologically, with notes on their stratigraphic occurrences (Matsumoto, 1960 with notes on stratigraphy by Amano *et al.*). The *Graysonites* bearing member of the middle formation of the Goshonoura Group consists of siltstone and rather fine-grained sandstone, but it contains bivalves of shallow sea environments. The specimens of *Graysonites* from this member are more or less fragmentary, although they include damaged adult shells. Completely preserved adult shells like those of the Soeushinai area have not been reported from the Goshonoura Group. In other words, they must have been transported from their original habitat and broken by waves in some shallower part near the embedded site.

Anyhow, in this paper we primarily aim at proposal of a problem about the distribution and habitat of *Graysonites* and *Utaturiceras*. We never intend to give here a final conclusion, although some discussion is given above. The problem should be investigated further from various angles.

6. Summary of results

(1) On the basis of the material from the Cretaceous area of Hokkaido, as well as the previous ones, the two genera *Utaturiceras* Wright, 1956 and *Graysonites* Young, 1958 of the ammonoid family Acanthoceratidae are redefined.

(2) Three species of *Utaturiceras*: *U. vicinale* (Stoliczka, 1864), *U. chrysanthemum* sp. nov., and *U. cf. discoidale* (Kossmat, 1895), and also two species of *Graysonites*: *G. wooldridgei* Young, 1958 and *G. adkinsi* Young, 1958, from the Soeushinai area, NW Hokkaido, are described with clearer definition.

(3) Stratigraphically the treated specimens of the

above species all came from the Member My3 of the Middle Yezo Subgroup in the studied area. *G. wooldridgei*, *G. adkinsi*, *U. vicinale* and *U. chrysanthemum* characterize an assemblage zone in the basal part of the Cenomanian sequence of strata. *Mrhiliceras lapparenri* (Pervinqui re) is also an element of this zone.

(4) As is supported by the integrated biostratigraphic and radiometric study of recent issue (Obradovich *et al.*, 2002), the above defined zone in Hokkaido would work as a reference zone for the worldwide correlation of the basal part of the Cenomanian Stage. In fact, elements of this zone have been reported from a number of distantly separated regions of the world. There are, however, some problems about the environmental and other aspects of the faunal elements, as discussed in the last chapter.

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北海道産の白亜紀セノマニアン初期アンモナイト類*Utaturiceras*及び*Graysonites*

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アンモナイト類Acanthoceratidae科の*Utaturiceras*及び*Graysonites*の2属は、北海道北西部の添牛内地区の白亜系セノマニアン階下部にかなり産出する。それに基づき両属の特徴を改めて認定し、*U.*属の3種(内1種は新種)と*G.*属の2種を記載し、それらの特徴を明示した。*U. vicinale* (Stoliczka), *U. chrysanthemum* n. sp., *G. wooldridgei* Young, *G. adkinsi* Youngはセノマニアン最下部を特徴付ける。しかしこれらが国内でも海外でも散点した地区からその産出が報告されている事実が気付かれ、若干論述を試みたが、産状についての結論にはさらに研究を重ねるべきである。