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Some acanthoceratid ammonites from the Yubari Mountains, Hokkaido—Part 2

(Studies of Cretaceous ammonites from Hokkaido—LXV)

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北海道夕張山地産のアカントケラス科アンモナイトのいくつか —その2—

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アカントケラス科の系統分類に関し欧米で最近かなりの改変が提案された。その中で，*Cunningtoniceras* が *Euomphaloceras* とは別系統として復活されている。これに対応して日本側の資料に基づき，追認と批判を試みた。その上で次の諸種を記載した。
(1) *Cunningtoniceras takahashii* (MATSUMOTO)：従来 *Acanthoceras* に入れていた。*Cunningtoniceras* COLLIGNON, 1937の復活に伴ない，理由を述べて同属に移す。なおM殻(Dic=210~250mm)とm殻(同 155~170mm)の二型を認めた。また *C. amphibolum* (MORROW)とは明確に識別できる。両種はセノマニアン中部に特徴的であるが，後者は前者の次に上位の亜帯に産する。(2) *C.* cf. *diadema* (SPATH)：西欧のセノマニアン中部産の本種では内のワールの外面の形質が不明確，日本のでは外のワールの住房が不完全，従って同定は暫定的。*C. takahashii* の産地で採集。(3) *C.* aff. *lonsdalei* (ADKINS)：北米テキサスのセノマニアン中部産の *C. lonsdalei* に近縁のものをパンケモユーパロ川右岸(PK101)から得た。ここは *Inoceramus hobetsensis* や *Romaniceras* を産し，チューロニアン中部である。二次化石か，*C.* 属の生存期間が伸びるのか，注意すべき事実として報告した。(4) *C. meridionale* (STOLICZKA)：本種は最近 *C. cunningtoni* (SHARPE)のシノニムか亜種とされている。しかしインド産のレクトタイプならびに北海道産の資料に基づき別種と決断し，その独特な形質が幼殻(D=7~12mm)にすでに出現することをも示した。時代は幾春別川流域のも大夕張のもセノマニアン中部である。

Introduction

Suceeding Part 1 by MATSUMOTO and SUEKANE (1987), we take in this paper (Part 2) particularly ammonites of the genus *Cunningtoniceras* COLLIGNON, because considerable revisions have been made recently in the taxonomy and phylogeny of this and relevant genera.

The material of this paper consists primarily of T.S.'s collection and Y.K.'s acquisitions subsequent to the work of MATSUMOTO *et al.* (1985). Some of the species from the Yubari Mountains which were described in previous papers are also dealt with on this occasion in the light of the

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revised taxonomy mentioned above.

A route map in Part 1 (MATSUMOTO and SUEKANE, 1987, text-fig. 1) may be useful for some of the localities in Part 2. Locality S208 is indicated in that map. Loc. Y5301 was not indicated but should be pointed at the immediate south of the second bridge of the forestry road (i.e. Kaneobetsu Rindo in that map) on the left side of the stream Kaneobetsu-zawa. In Fig. 6 of this paper, SUEKANE's loc. PK101 (=T.M.'s loc. Y5406) is indicated.

The described specimens of T. SUEKANE's Collection are donated to the Yokosuka City Museum (YCM); those of Y. KAWASHITA's Collection are temporarily held at his house but will be soon kept in the Mikasa City Museum (MCM). In addition to YCM and MCM, other specimens to be redescribed or mentioned in this paper are held in the following institutions, with abbreviation in parentheses:

Geological Collections, Kyushu University, Fukuoka (GK.)

Geological & Mineralogical Collections, Hokkaido University, Sappro (GMH.)

University Museum, University of Tokyo, Hongo, Tokyo (UMUT.) (=previously indicated as GT.)

Some of the specimens kept in the British Museum (Natural History) (BMNH), London; Bureau of Economic Geology (BEG) (now Texas Memorial Museum), Austin; U.S. National Museum (USNM), Washington, D.C. and the Geological Survey of India (GSI), Calcutta, may be cited in comparison with ours.

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Palaeontological descriptions

Family Acanthoceratidae DE GROSSOUVRE, 1894

Genus *Cunningtoniceras* COLLIGNON, 1937

Type species: *Ammonites cunningtoni* SHARPE, 1855, by absolute tautonymy. When COLLIGNON (1937, p. 64) proposed this new genus with diagnosis, he did not designate a particular species as the type species but enumerated several species as examples, in which *C. cunningtoni* (SHARPE) was included. Therefore, this species is the type species by absolute tautonymy, as COBBAN (1987, p. 9) stated.

In previous descriptions of the acanthoceratid ammonites from Japan (e.g. MATSUMOTO *et al.*, 1957; MATSUMOTO *et al.*, 1969), the authors followed WRIGHT and WRIGHT (1951, p. 29) in regarding *Cunningtoniceras* COLLIGNON, 1937 as a junior synonym of *Euomphaloceras* SPATH, 1923.

COBBAN (1987, p. 9; also in KIRKLAND and COBBAN, 1986, p. 2) recently has taken notice that the two genera are morphologically distinguished especially by the shape and breadth of L and E/L saddle. Matsumoto *et al.* (1969, p. 270) stated in the diagnosis of *Euomphaloceras* (*sense lato* at that date) that L may vary in breadth and shape.

The suture of *E. euomphalum* (SHARPE) (1853, pl. 13, fig. 4) (see also CRICK, 1899, text-figs. 1, 2) is fairly similar to that of *Calycoceras* (*Lotzeites*) *aberrans* (KOSSMAT) (1895, pl. 24, fiig. 4), in the latter of which the inner half of E/L saddle is so much declined that a peculiar shape of L is formed. Even in some examples of *Acanthoceras* and *Cunningtoniceras*, we see the tendency to such modification of E/L saddle (e.g. KENNEDY and HANCOCK, 1970, text-fig. 2 for the lectotype of *A. rhotomagense*; also KOSSMAT, 1897, pl. 5, fiig. 1c for an example of *C. cunningtoni*).

In the genus *Kamerunoceras* REYMENT, 1954 as redefined by KENNEDY and WRIGHT (1979), there are two types of sutural pattern. One is represented by *K. eschii* (SOLGER) and *K. turoniense*

(D'ORBIGNY), whose sutures are of typical *Acanthoceras* pattern, showing massive, bipartite E/L saddle and fairly narrow L (see REYMENT, 1954, text-fig. 2; KENNEDY and WRIGHT, 1979, text-fig. 2). The other is shown by *K. inaequicostatum* (WIEDMANN) and *K. isovokyense* (COLLIGNON), whose sutures are of *Euomphaloceras* type (see WIEDMANN, 1960, fig. 3; COLLIGNON, 1965, pl. 388, fig. 1663). For the latter species group *Schidewolfites* WIEDMANN, 1960 should be revived, although it has been suppressed as a synoym of *Kamerunoceras*.

In many examples of the genera (or subgenera) *Romaniceras* SPATH, 1923 (e.g. see JIMBO, 1894, pl. 21 [5], fig. 1b; MATSUMOTO and UCHIDA, 1985, text-fig. 1c; pl. 1, figs. 1–2), *Yubariceras* MATSUMOTO *et al.*, 1957 (fig. 9) and *Shuparoceras* MATSUMOTO, 1975 (fig. 3), their sutures are of *Acanthoceras* pattern. These multituberculate ammonites and *Kamerunoceras* have been assigned to the subfamily Euomphaloceratinae COOPER, 1978. In other words, COBBAN's *Euomphaloceras* type suture is not consistently kept in this subfamily, unless the subfamily is redefined.

KIRKLAND and COBBAN (1986, p. 2) reckon a smaller adult size of *Euomphaloceras* as one of the criteria to distinguish it from *Cunningtoniceras*. This may be correct, if we take *E. septemseriatum* (CRAGIN) (see COBBAN and SCOTT, 1972, pl. 12; WRIGHT and KENNEDY, 1981, pls. 12, 13; KENNEDY, 1988, pls. 8, 9) as an example, but the hitherto illustrated specimens of *E. euomphalum* are wholly septate (e.g. WRIGHT and KENNEDY, 1981, pl. 11) and some of them are certainly immature. It is too bad that we have no example of *E. euomphalum* in the correct sense from Japan. As to the size and characters of the adult body chamber of this species, little information is available. KENNEDY (1971, p. 92) recorded the presence of a larger adult shell, with D=120 mm if restored.

WRIGHT and KENNEDY (1987, p. 193–195) rightly remarked that *C. inerme* (PERVINQUIÈRE, 1907), the most primitive species of the genus, is closely allied to some forms of *Acanthoceras rhotomagense*. They interpret (*in* KENNEDY, 1988, p. 53) that *Euomphaloceras* originated in *Lotzeites* WIEDMANN, 1960. *Acanthoceras aberrans* KOSSMAT, 1895 (pl. 24, fig. 4), the type species of *Lotzeites*, has somewhat modified suture as mentioned above.

The ornament as well as the shell-form may be also important for the discussion of the affinities. *L. aberrans* has indeed peculiar ornament and shell-form as compared with typical species of *Acanthoceras*. We should like to notify that *Ammonites meridionale* STOLICZKA, 1864 has spinose tubercles, intercalated flank ribs and constrictions (see the revised description in this paper). *C. multicostatum* (BASSE, 1940) (p. 446, pl. 6, fig. 2), which seems to show incipient constrictions, and possibly *C. asura* (MATSUMOTO et MURAMOTO) (*in* MATSUMOTO *et al.*, 1969, p. 277, pls. 35, 36) may be on similar, if not on the same, evolutionary trends in showing some characters which resemble those of *Euomphaloceras*. We should like to have more material for the inspection of the ventral part of the inner whorl of these two species. As their sutures are rather of *Acanthoceras* pattern, we refer them to *Cunningtoniceras*.

Apart from the above discussions about some unsettled problems in taxonomy and phylogenetic relationships, some of the species from Japan which were assigned to the genus *Euomphaloceras* should be transferred to *Cunningtoniceras*. In addition to them, some other species which were described under the genus *Acanthoceras* should also be revised to *Cunningtoniceras*. Such revisions may be exemplified in the descriptions below. WRIGHT and KENNEDY (1987, p. 194) have already pointed out that the ammonite (GT. I-3165) [UMUT. MM5664] from the Teshio Mountains which MATSUMOTO *et al.* (1957, p. 33, pl. 14, fig. 2) described as *Acanthoceras* aff. *evolutum* SPATH is identified with *C. inerme*. We should call it *C.* aff. *inerme*, because unlike typical *C. inerme* its extra minor ribs are not confined within the venter but extend frequently to the flank. Furthermore, *Euomphaloceras* cf. *euomphalum* by MATSUMOTO *et al.* (1957, p. 34, pl. 15, fig. 3: UMUT. MM5665=GT. I-3186 from loc. T

621) is an example of a microconch of *C. cunningtoni*.

Cunnigtoniceras takahashii (MATSUMOTO)

Figures 1, 2

1975. *Acanthoceras takahashii* MATSUMOTO, p. 126, pls. 16–17; text-figs. 9–10.

1985. *Acanthoceras takahashii* MATSUMOTO; MATSUMOTO *et al.*, p. 156, pls. 1–3; text-fig. 1.

Material: In addition to the previously described holotype, GK. H5605 (MATSUMOTO, 1975, pl. 16; text-fig. 9), and paratype, GK. H5606 (*op. cit.*, pl. 17, fig. 1) from the Ikushumbets [=Ikushunbetsu] area and also a fine specimen of Y.K.'s subsequent collection (YKC. 570814) (MATSUMOTO *et al.*, 1985, pls. 1–2) and another (YKC. 590715) from the Oyubari area, there are more specimens, e.g. YKC. 610518 (Fig. 1) from loc. Y5301, M. KAWANO's (Fig. 2) from loc. Ik1101 of Ikushumbets section, now kept in MCM (550705–16), and Y.K's from the same locality.

Description: YKC. 610518 lacks the last part of the body chamber. Its original size is probably not much different from the paratype and two YKC specimens described already, because its head of the last suture is at D=120 mm or the end of the siphuncle is at the D(ic)=115mm, being generally similar to the records in the two previous papers (MATSUMOTO 1975, p. 126; MATSUMOTO *et al.*, 1985, p. 157).

The specimen of M. KAWANO's Collection (Fig. 2) is as large as the holotype (MATSUMOTO, 1975, pl. 16, fig. 1), about 250 mm in the maximum costal diameter or 210 mm in intercostal diameter and about 165 mm at the end of phragmocone. They may be macroconchs.

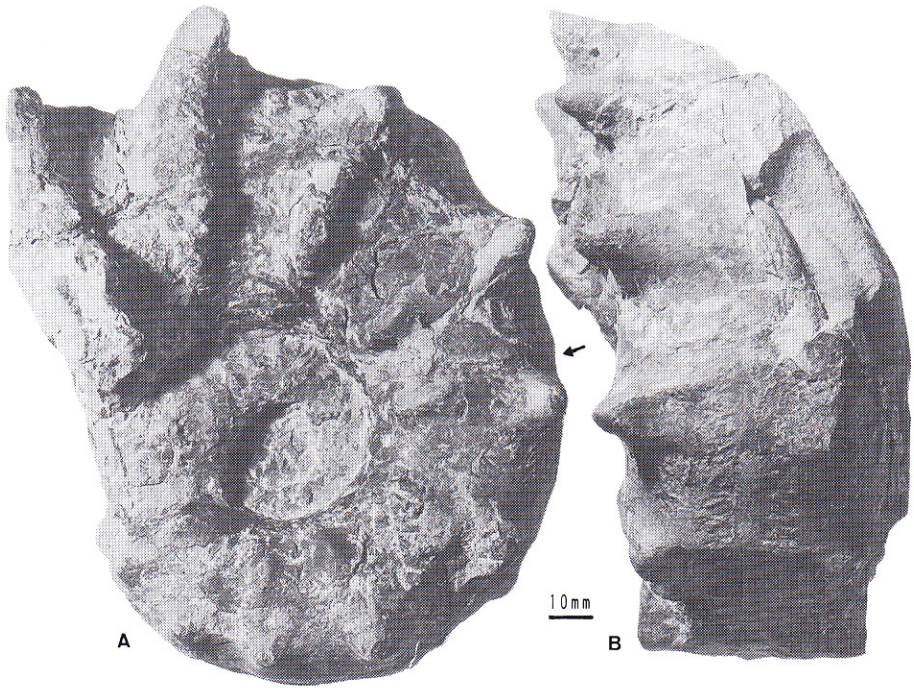

Fig. 1 *Cunningtoniceras takahashii* (MATSUMOTO), microconch. YKC. 610518, collected by Y.K. from loc. Y5301, Kaneobetsu-zawa, Oyubari area. Arrow: head of last suture. In this paper different views of the same specimens are in the same fig. number. For brevity, the self explaining views, such as lateral, back, frontal, etc. are omitted from writing.
All the photos (Figs. 1, 2, 4, 5, 8, 9) by courtesy of M. NODA.

This species is characterized by the magnificent adult shell, whose outer whorl is much depressed, with subquadrate section, and has 11 or 12 prominent major ribs at wide intervals, which are provided with bullate umbilical tubercles, whose heads are shifted outward from the umbilical border, and large, horned tubercles at the ventrolateral shoulder. These ribs weaken but are often doubled on the venter with faintly remained, outer ventrolateral and siphoral clavi on the septate part, whereas on the body chamber they are much raised on the flank and even on the venter with flared ventrolateral horns, which strech alternately or irregularly sideward and obliquely upward.

The inner whorl has weaker and more numerous, long ribs and also shorter intercalated ribs, the latter of which are often long enough to be observable on the flank but have no umbilical tubercles. There are also occasionally intercalated very short ribs, which have inner ventrolateral tubercles as those of longer ones. Therefore, the multiple ribs and tubercles should exist on the venter of the inner whorl. This feature is observable in some specimens of favourable preservation but does not persist to the last part of the septate whorl, where some ribs are doubled on flank and on venter, being looped at the ventrolateral tubercles.

The suture is generally similar to that of *Acanthoceras*, as in other species of *Cunningtoniceras*, with fairly deep and roughly subrectangular E and L, massive, roughly subquadrate and bipartite E/L saddle and other smaller elements. Minor lobules are fairly deep and narrow in the late stage.

Dimensions: See Table 1.

Comparison and discussion: This species looks to be generally similar to *C. cunningtoni* in the characters of the outer whorl, but is distinguished by the much raised ribs with flared ventrolateral horns in its adult body chamber and finer and more numerous ribs in the inner whorl. *C. cunningtoni* has distant major ribs (6 per half

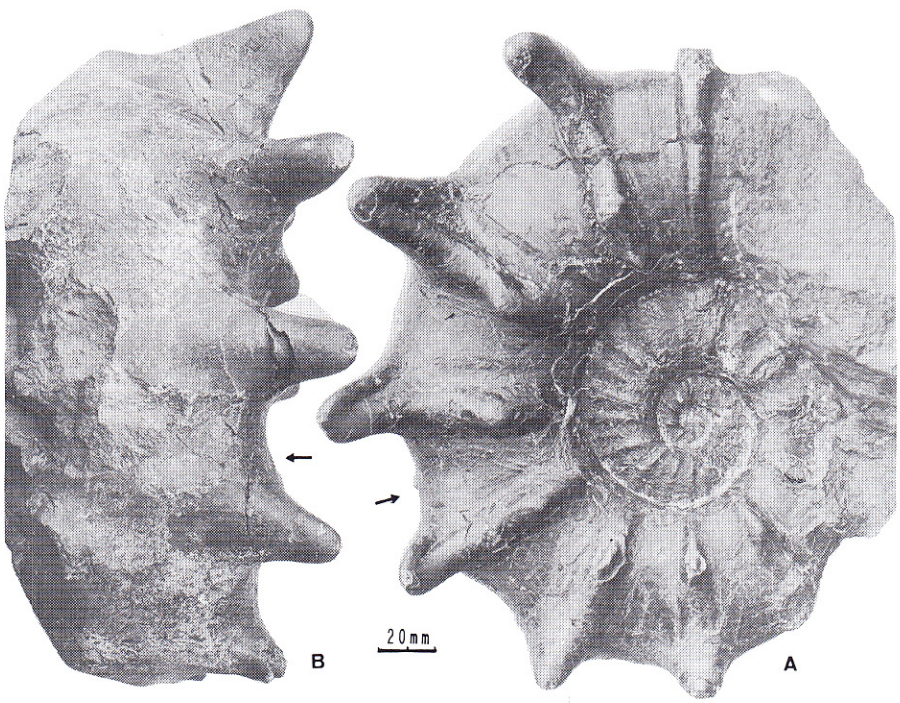

Fig. 2 *Cunningtoniceras takahashii* (MATSUMOTO), macroconch. M. KAWANO's Coll. from loc. Ik 1101, Ikushumbets, now kept in MCM.

Table 1. Measurements on selected specimens of *Cunningtoniceras takahashii*.

Specimen, position		D	U	H	B	B/H	H/h	R/2
YKC. 610518, E-60°	(c)	142 (1)	43 (.30)	62 (.44)	84 (.59)	1.35	—	6
〃 E-75°	(ic)	132 (1)	42 (.32)	54 (.41)	~69 (.52)	1.28	1.5	6
〃 LS	(ic)	~120 (1)	38 (.32)	48 (.40)	~63 (.53)	1.31	1.41	6
YKC. 570814	(c)	172 (1)	65 (.37)	58 (.34)	73 (.42)	1.26	1.18	6
〃	(ic)	156 (1)	63 (.40)	53 (.34)	65 (.42)	1.23	1.32	6
GK. H5605	(c)	192.5 (1)	65.5 (.33)	76 (.39)	~104 (.54)	1.37	1.43	6
〃	(ic)	176 (1)	62.5 (.35)	62.5 (.35)	~76 (.43)	1.21	1.23	6
KAWANO's E-40°	(ic)	200 (1)	72 (.36)	76 (.36)	~99 (.50)	1.30	1.46	6

D=diameter, U=width of umbilicus, H=whorl-height, B=whorl-breadth, h=whorl-height 180° prior to H, R/2=number of ribs per half whorl up to the measured point, E=preserved end, LS=last septum, i.e. bottom of body chamber, (c)=costal, (ic)=intercostal, ~=approximate.

whorl) in both the outer and the next inner whorls.

The holotype of *C. cunningtoni* (SHARPE, 1855) (see WRIGHT and KENNEDY, 1987, text-figs. 76–77), which one of us (T.M.) once observed at BMNH, has the last septum at intercostal diameter=135 mm and is somewhat smaller than the holotype and other macroconchs of *C. takahashii*. An example from South India described by KOSSMAT (1897, p. 18, pl. 5) is septate at its preserved end, whose diameter is 154mm. On the other hand, ZABORSKI (1985, figs. 47–48) has shown smaller examples of his *C. cunningtoni cunningtoni* in which the intercostal diameters are 73 mm and 80 mm at the last suture. Other examples of *C. cunningtoni cunningtoni* from the Middle Cenomanian of Nigeria (ZABORSKI, 1985, figs. 50, 52) are still septate at the preserved end with diameters over 90 mm and the largest of his material is recorded as 150 mm in diameter, without mentioning the position of the last septum. The available material seams to suggest that dimorphic pairs, macroconchs and microconchs, existed in *C. cunningtoni*.

In *C. takahashii* there is a probable dimorphic pair, as mentioned above. YKC. 601020 (Fig. 4) which we call tentatively *C.* cf. *diadema* might be a microconch of *C. takahashii*, although we should search for further material.

Cunningtoniceras arizonense KIRKLAND and COBBAN (1986, p. 2, figs. 1–3; pls. 1–8), from the Late Cenomanian *Metoicoceras mosbyense* Zone of Arizona, resembles *C. takahashii* in the strengthened major ribs with enormous ventrolateral horns of the body chamber, but its whorl is less depressed than that of *C. takahashii* and its inner whorl has much coarser and denser ribs with coarser tubercles than in that of *C. takahashii*. The holotype and other specimens of *C. arizonense* are much larger than those of *C. takahashii*; the maximum intercostal diameter behind the apertural flange is 450 mm in the former as compared with 176 mm (micro-) or 210 mm (macroconch) in the latter.

Acanthoceras amphibolum (MORROW), withwhich *A. takahashii* was compared as an allied species (MATSUMOTO, 1975, p. 129), has been recently transferred to *Cunningtoniceras* by COBBAN (1987, p. 9). COBBAN's precise descriptions and fine illustrations enlighten us to state that *C. takahashii* is clearly distinguished from *C. amphibolum* by its much broader whorls, wider umbilicus, less involution, strongly raised ribs with irregularly flared ventrolateral horns on its adult body chamber, and the frequent intercalation of shorter flank ribs without umbilical tubercles on its inner whorl. A form of *C. amphibolum* from Hokkaido (MATSUMOTO *et al.*, 1969, p. 266, pl. 31, fig. 1) is likewise different from *C. takahashii*,

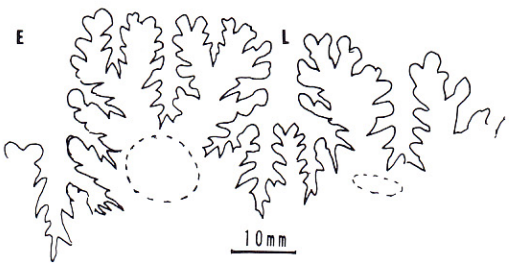

Fig. 3 *Cunningtoniceras amphibolum* (MORROW). Last external suture of GK. H5593 from loc. Ik 1049, Ikushumbets area. (T.M.*delin.*)

although its suture (Fig. 3) has a narrower stem of L and deeper incisions than that of American examples.

Occurrence: The localities of the holotype and paratypes are in the lower but not basal part of the Lower Member (IIb) of the Mikasa Formation in the section on the eastern wing of the Ikushumbets anticline (see MATSUMOTO *et al.*, 1978, figs. 6–8). This part should now be called tha Zone of *Cunningtoniceras takahashii*, with which *C. meridionale* (STOLICZKA) is associated (e.g. at loc. Ik 1052). It is somewhat above the Zone of *Mantelliceras japonicum*, which contains numerous associated ammonites in the silty fine-grained sandstone, with ammonite poor, bivalve bearing sandstone between the two zones. Above the bed with *C. takahashii*, in the greenish dark grey, silty find-grained sandstone, there is the Subzone of *Calycoceras* (*Newboldiceras*) *orientale*, in which *C, amphibolum* occurs (at loc. Ik 1049 instead of erroneously recorded Ik 1051).

Localities in the Oyubari area are T.M.'s Y5301 and another nearby place on the left side of the stream Kaneobetsu-zawa. Among the associated fossils there is a probably new (but not yet described) species which is allied to *Calycoceras* (*Newboldiceras*) *vergonsense* COLLIGNON, 1937 from the fourth zone (Zone of *Acanthoceras rhotomagense*) of THOMEL (1972, p. 12), the upper part of the bipartite Middle Cenomanian in southeastern France. From the same mudstone outcrop of Y5301, Y.K. obtained *Inoceramus reduncus* PERGAMENT, which is recorded to occur some where in the Middle Cenomanian and the lower Upper Cenomanian in several places of Hokkaido (MATSUMOTO *et al.* 1988).

To sum up, *Cunningtoniceras takahashii* is a diagnostic species which marks the Middle Cenomanian in Hokkaido.

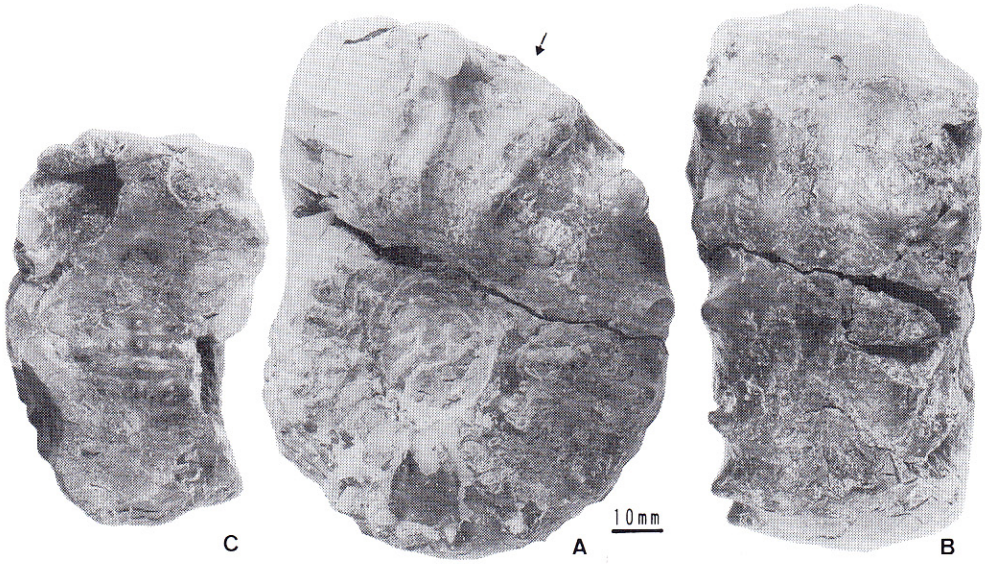

Fig. 4 *Cunningtoniceras* cf. *diadema* (SPATH). YKC. 601020, collected by Y.K. from loc. Y5301, Kaneobetsu-zawa, Oyubari area. See text for 4c.

Cunningtoniceras cf. *diadema* (SPATH)
Figure 4

Compare:

1863. *Ammonites cunningtoni* PICTET (*non* SHARPE), p. 32, fig. 1 (=WRIGHT and KENNEDY, 1987, text-fig. 70 B, D, E).

1926. *Acanthoceras diadema* SPATH, p. 426, 431.

1987. *Cunningtoniceras diadema* (SPATH); WRIGHT and KENNEDY, p. 204, text-fig. 81.

Material: YKC. 601020 obtained by Y.K. from loc. Y5301 on the left side of the Kaneobetsu-zawa.

Description: This specimen shows the end of siphuncle at D=95 mm and preserves only a fraction (40°) of the body chamber. Should the body chamber be assumed as roughly a half whorl, the entire shell diameter would be about 160mm.

The whorl is much broader than high, broadly subquadrate in an intercostal section, with B/H=1.36 at the preserved end. The venter on the outer half whorl is wide and roughly flat and that on the preceding part is broadly convex. The whorl expands with a moderate ratio, encircling the deep umbilicus of moderate width (31% of D).

About 200° of the preserved outer whorl is ornamented with 9 major ribs at moderately wide intervals, of which 8 are on the last half whorl of the phragmocone. These ribs have bullate umbilical tubercles, whose peaks are shifted somewhat outward from the umbilical edge, and larger ventrolateral tubercles, whose peaks strech laterally. They cross the broad venter nearly at right angle with the siphonal line, though somewhat weakened, and at least some of them are doubled and looped at the ventrolateral tubercles. A very low siphonal elevation and faint outer ventrolateral nodes or clavi are discernible.

The ribs on the preceding part of the septate whorl are denser and weaker than the major ribs described above, separated by the interspaces as wide as or slightly wider than the ribs and the tubercles are smaller. The ventral part of the inner whorl is observable, when the last one third of the preserved outer whorl is detached along a fissure (see Fig. 4C). It shows crowded ribs branched from or intercalated between the extensions of the flank ribs and the siphonal and also outer ventrolateral tubercles which are twice as numerous as the inner ventrolateral ones.

The suture is of *Acanthoceras* pattern, with massive and large, bipartite E/L saddle, fairly deep and roughly subrectangular L, smaller L/U2 saddle and U2.

Dimensions: See Table 2.

Comparison and discussion: According to WRIGHT and KENNEDY (1987, p. 204), the holotype of *C. diadema* is lost, but we depend on their concise diagnosis based on a number of specimens from the Middle Cenomanian of Le Mans (France) and their illustration (*op. cit.*, text-fig. 81) of a representative specimen to understand this species.

The described specimen from loc. Y5301 of Hokkaido is quite similar to *C. diadema* in essential features, except for the difference in size. The diameter of our specimen in a restored outline is 160mm, whereas that of the French specimen is recorded as 208mm. Ours may be a microconch.

Table 2. Measurements of *Cunningtoniceras* cf. *diadema* (above) and *C. diadema* (below).

Specimen, position		D	U	H	B	B/H	H/h	R/2
YKC. 601020, E		105.0 (1)	32.5 (.31)	42.5 (.31)	~58.0 (.55)	1.36	1.42	8
〃 E-30°	(LS)	97.0 (1)	31.5 (.32)	39.5 (.41)	~52.0 (.55)	1.32	1.52	8
W. & K. 1987, fig. 81	(ic)	200.0 (1)	70.0 (.35)	79.0 (.40)	~97.0 (.49)	1.23	1.55	8
〃 −90°	(ic)	161.0 (1)	57.5 (.36)	63.5 (.39)	~80.0 (.50)	1.26	1.59	9

W. & K.=WRIGHT and KENNEDY.

The difference between the two specimens in the ratio of U/D and that of B/H are not great and can be regarded as variations within a species. WRIGHT and KENNEDY complained that the characters of the inner whorls are not well shown by the French material. The ribs on the flank of the inner whorl show similar density and fineness between the two specimens. Our specimen shows by chance the characters of the ventral part of the inner whorl. Should a similar feature be confirmed in the French material, we would conclude the specific identity. In the present circumstances we call our form tentatively *C.* cf. *diadema*. As an alternative interpretation it could be a microconch of *C. takahashii*, whose middle aged whorl has ribs of similar density.

Occurrence: This specimen was obtained by Y.K. from loc. Y5301 on the left side of the Kaneobetsu-zawa. This is an important locality where a typical form of *C. takahashii* was obtained among other species.

Cunningtoniceras aff. *lonsdalei* (ADKINS)
Figure 5

Compare:

1928. *Acanthoceras lonsdalei* ADKINS, p. 244, pl. 26, fig. 5; pl. 27, fig. 3.

1955. *Euomphaloceras lonsdalei* (ADKINS); STEPHENSON, p. 62, pl. 6, figs. 6–20.

1963. *Euomphloceras lonsdalei* (ADKINS); WRIGHT, p. 609, pl. 87, fig. 2; pl. 88, fig. 1; pl. 89, fig. 2.

1987. *Cunningtoniceras lonsdalei* (ADKINS); WRIGHT and KENNEDY, test-fig. 80.

Holotype: The single specimen illustrated by ADKINS (1928, pl. 26, fig. 5; pl. 27, fig. 3), from the basal member of the Eagle Ford Group, Belton-Temple road, Bell County, Texas. It was in the Bureau of Economic Geology, when one of us (T.M.) examined it in 1957, but the biginning of its body chamber (later than a fissure shown by ADKINS (1928, pl. 26, fig. 5) was missing. WRIGHT and KENNEDY's (1987 text-fig. 80) illustration is the surviving septate part. It is now in the collections of the Texas Memorial Museum.

Material: YCM-GP 718 (Fig. 5), collected by T.S. from his loc. PK101 [=T.M.'s Y5406] on the right side of the stream Panke-moyuparo.

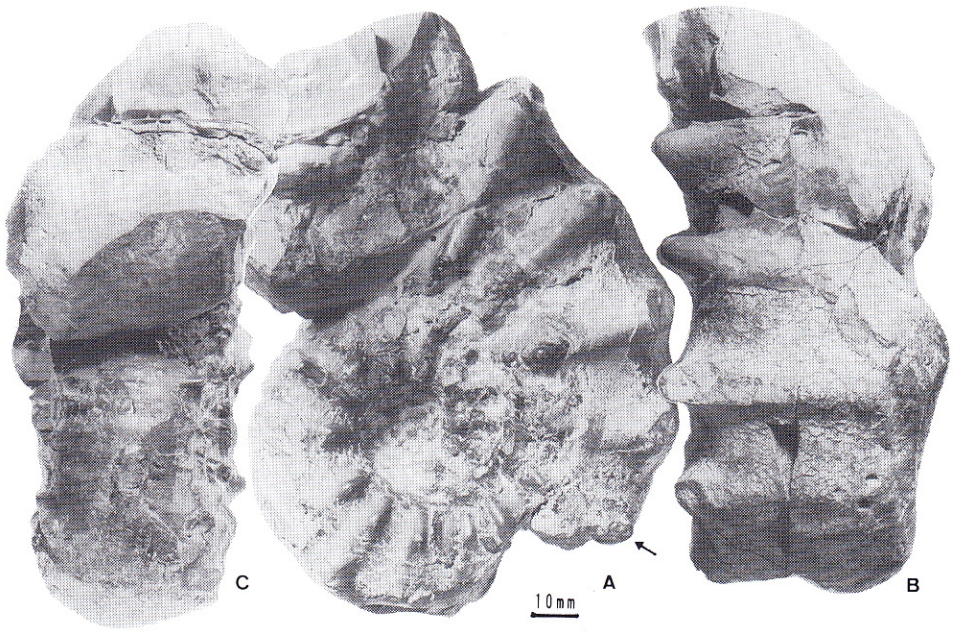

Fig. 5 *Cunningtoniceras lonsdalei* (ADKINS). YCM-GP 718, collected by T.S. from loc. PK101, Panke-moyuparo, south of the Lake Shuparo.

Description: This specimen is about 120 mm in intercostal diameter at the preserved end. Its body chamber remains for nearly 150° in the outer whorl, although its last part (about 40°) is covered by the rock matrix which is hardly taken out. The last septum is at about 85 mm in intercostal diameter.

The whorl expands with a moderate ratio, encircling the umbilicus of moderate width, with fairly high, nearly vertical or steeply inclined wall. The whorl is much broader than high. The body chamber is broadly squarish especially in costal section, with a nearly flat, broad venter, but the intercostal section of the septate whorl is somewhat rounded, with broadly arched venter and abruptly rounded umbilical edge.

Six major ribs on the preserved main part of the body chamber are strong, rectiradiate and separated by smooth interspaces of moderate width. The bullate umbilical tubercles are pointed at a slight distance outside the umbilical border; the inner ventrolateral tubercles are strong, stretching mainly laterally and slightly upward. The ribs cross the venter vertically; the first two are low and double, being looped at the inner ventrolateral tubercles, whereas outer ventrolateral and mid-ventral small nodes survive faintly. The rest four ribs are somewhat raised on the venter.

The mojor ribs on the last half whorl of the septate stage are 7 and those on the preceding half whorl are also 7. In other words the density of the major ribs are nearly constant on the flank of the observable full one whorl of the phragmocone. They are fairly strong and provided with prominent umbilical and inner ventrolateral tubercles. The peaks of the umbilical tubercles are situated at a little distance outside the umbilical edge. The ventral part of the middle growth-stage with diameters from 50 to 70 mm are exposed, where there are fairly crowded secondary ribs. One major flank rib corresponds normally to three ventral secondaries, of which two are divided at the inner ventrolateral tubercle from the primary and another is inserted. The secondary ribs on the venter have the outer ventrolateral and siphonal, minor tubercles, some of which are rounded and of moderate intensity and others rather weak and may be bullate (i.e. elongated along the rib).

The above ornaments are on the broadly rounded venter and tend to weaken adorally in the last part of the septate stage.

The sutures are fairly well exposed and characterized by fairly narrow, deep and roughly subrectangular L, massive, roughly subquadrate and bipartite E/L saddle, and smaller L/U2 saddle.

Dimensions: See Table 3.

Comparison: This specimen favourably shows the characters of the body chamber and the preceding one whorl of the phragmocone. Its shell diameter at the last septum is almost the same as that of the holotype. The last one whorl of its septate stage is essentially similar to that of the holotype in shell form and ornamentation, but the latter is somewhat more involute and has a narrower unbilicus than the former. As the body chamber is missing in the holotype, we should state that our form is allied to *C. lonsdalei*.

Table 3. Measurements of *Cunningtoniceras* aff. *lonsdalei* (above) and *C. lonsdalei* (below).

Specimen, position		D	U	H	B	B/H	H/h	R/2
YCM-GP 718, E-55°	(c)	116.8 (1)	41.3 (.35)	45.2 (.39)	~61.0 (.52)	1.35	1.49	8
〃 E-95°	(ic)	100.0 (1)	34.0 (.34)	39.0 (.39)	~52.0 (.52)	1.33	1.44	8
〃 E-150° (LS)	(ic)	85.5 (1)	28.0 (.33)	34.0 (.40)	47.0 (.55)	1.38	1.45	7
Holotype, LS	(ic)	83.0 (1)	25.0 (.30)	?35.0 (.42)	47.0 (.55)	1.34	—	7
〃 LS-90°	(ic)	69.0 (1)	21.5 (.31)	28.5 (.40)	36.5 (.53)	1.33	1.38	7

C. cunningtoni [=*C. cunningtoni cunningtoni* by some authors] has somewhat smaller ratios of B/H than those of *C. lonsdalei* (compare Table 4 with Table 3). This was misunderstood by some authors, who stated that *C. lonsdalei* has less depressed whorl section than *C. cunningtoni* (s.s.), without showing the measurements. The mojor ribbing of *C. lonsdalei* is rather denser than that of *C. cunningtoni* (14 per whorl in the former as compared with 12 in the latter).

GMH. 12439 from loc. Oy 58 of S. NAGAO and A. OSANAI, Hakkin-zawa, which was described under *Euomphaloceras* [*Acanthoceras*?] sp. indet. (MATSUMOTO *et al.*, 1957, p. 35, pl. 17, fig. 1 only) may be an example of *C. lonsdalei*. Its whorl looks, however, less wide than the holotype and the above specimen, but this is probably due to the secondary compression affected strongly its right side. As another alternative, it could be referred to *C. inerme* (PERVINQUIERE), but its ribbing is not so dense as that of GT. I-3165 [=UMUT. MM 5664] from the Saku-Abeshinai area described under *Acanthoceras* aff. *evolutum* SPATH (MATSUMOTO *et al.*, 1957, p. 33, pl. 14, fig. 2), now revised to *C.* aff. *inerme* (this paper, p. 31).

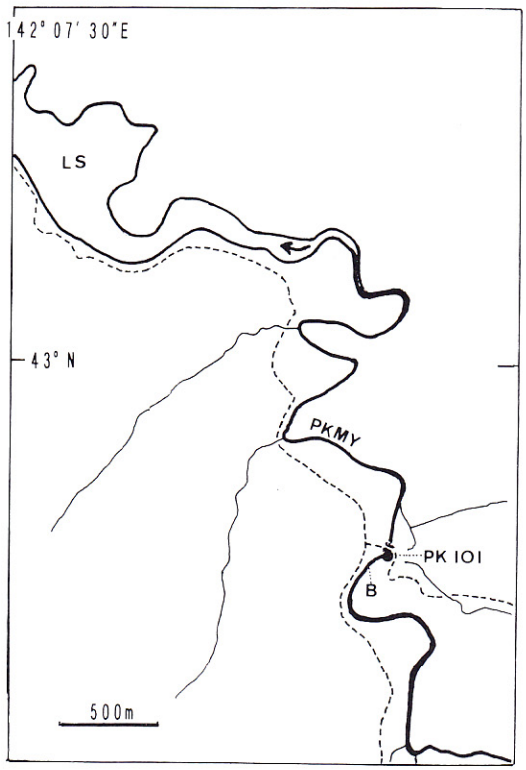

Fig. 6 Map showing the location of PK101 on the right bank of the River Panke-moyuparo (PKMY), running northward to the Shuparo Lake (LS). B: abandoned railway bridge. Broken line: forestry road.

Occurrence: The specimen described in this paper (i.e. YCM-GP 718) was contained in a calcareous nodule in the mudstone exposed at loc. PK101 of T.S. [=T.M.'s Y5406] on the right side of the stream Panke-moyuparo (see Fig. 6). This mudstone should be, however, Middle Turonian, because it contains commonly *Inoceramus hobetsensis* NAGAO et MATSUMOTO and because *Romaniceras deverianum* (D'ORBIGNY) (a slender form which we call *R. yezoense* MATSUMOTO) was obtained there by T.S. Therefore, YCM-GP 718 could be a derived fossil from some Cenomanian rock, but its rock matrix looks quite similar to other nodules from loc. PK101.

If this was not a derived fossil, it follows that the genus *Cunningtoniceras* had a long range from Middle Cenomanian to Middle Turonian with a break of occurrence record from the uppermost Cenomanian and Lower Turonian. This would be an enigmatic affair, but unnegligible for the problem of the phylogenetic origin of *Neomphaloceras* and *Yubariceras*.

GMH. 12439 is from a locality Oy 58 of S. NAGAO and A. OSANAI on the Hakkin-zawa at a level stratigraphically much lower than PK101. It is associated with *Turrilites costatus* LAMARCK (see NAGAO *et al.*, 1954, pl. 9, fig. 1) and the mudstone exposed at loc. Oy 58 is certainly Cenomanian, probably Middle Cenomanian.

The holotype is from the basal member of the Eagle Ford Group in Texas and of Middle Cenomanian age.

Cunningtoniceras meridionale (STOLICZKA)

Figures 7, 8, 9

1864. *Ammonites meridionalis* STOLICZKA, p. 76, pl. 41,

figs. 1, 1a-c.

?1907. *Acanthoceras meridionale* (STOLICZKA); PERVINQUIÈRE p. 278, pl. 15, figs. 2–6.

1957. *Euomphaloceras* [*Acanthoceras*?] sp. indet; MATSUMOTO, SAITO and FUKADA, p. 35, pl. 18, fig. 1 (*non* pl. 17, fig. 1).

1969. *Euomphaloceras meridionale* (STOLICZKA); MATSUMOTO, MURAMOTO and TAKAHASHI, p. 272, pl. 33, figs. 1a-d, 2a-c, pl. 34, figs. 1a, b, text-fig. 6.

Lectotype: GSI. 175, which was described and illustrated by STOLICZKA (1864, p. 76, pl. 41, figs. 1a-c), designated by MATSUMOTO *et al.*, 1969 (p. 272).

Material: In addition to the previously described specimens, (GK. H5612, GK. H5613 and GK. H5592) from the Ikushumbets area (MATSUMOTO *et al.*, 1969), YCM-GP 731 (Fig. 8) obtained by T. S. from his Loc. S 208 and GMH. 12438 (MATSUMOTO *et al.*, 1957, pl. 18, fig. 1) collected by S. NAGAO and A. OSANAI from their loc. Oy 58, both on the Hakkin-zawa route of the Oyubari area are probably referred to this species. Also GK. H8333 to be mentioned below.

Description: In our opinion this species seems to have been misunderstood by several authors. One of us (T.M.) once examined in Calcutta GSI 175, the specimen described by STOLICZKA (1864, p. 76, pl. 41, figs. 1, 1a-c), that is the lectotype. It is wholly septate, representing probably a middle growth-stage. One can see in lateral view the bifurcation of the major ribs at the strong ventrolateral tubercles and the intercalation of minor ribs, some of which begin to appear at about the middle of flank. There are 12 major ribs on the flank of full one whorl. The umbilical tubercles are fairly prominent and their peaks are gradually shifted outward as the whorl grows. The inner ventrolateral tubercles are prominent and spinose at their peak, although often broken at their base on this specimen.

On the venter of an earlier half whorl minor ribs are not of equal strength and width; accordingly the outer ventrolateral and siphonal tubercles vary in strength and shape (nodose, clavate or bullate). Some of the outer ventrolateral tubercles are spirally connected by weak riblets instead of distinct clavi. In addition, there are weak and narrow grooves along some of the ribs, which, in T.M.'s view, can be called incipient constrictions.

On the venter of the later half of this septate whorl such grooves disappear and the looped ribs and inserted ones are alternated; the tubercles on them weaken generally; some of the outer ventrolateral ones are bullate but some of the siphonal ones are bluntly elevated. STOLICZKA failed to show precisely the above features in his figures. T.M.'s drawing in Fig. 7 may substitute for them.

The whorl is broadly subquadrate in section. Even in the intercostal section whorl-breadth (B) is much greater than whorl-height (H) (see Table 4). As the inner ventrolateral tubercles stretch laterally, the venter looks still broader in the costal section.

Although STOLICZKA treated a larger specimen, whose diameter is 230mm, it is now missing. Therefore, the characters of the adult body chamber in the material from India are unknown, except for the dimensions listed by him, indicating a very large ratio of B/H.

GK. H5612, from loc. Ik 1052 of the Ikushumbets area, described by MATSUMOTO *et al.* (1969, p. 272, pl. 33, figs. 1a-d) has the inner whorl and a part of the outer whorl. Although it is somewhat weathered, the inner whorl is essentially similar to the early part of the lectotype, showing weak constrictions on the venter. The outer whorl has distant major ribs, with outward shifted umbilical tubercles and larger ventrolateral horns which stretch mainly laterally and slightly upward. The ribs lower and broaden, may be indistinctly doubled, and cross the venter nearly vertically. In addition to them, there are on the interspaces of the major ribs a few, bullate elevations or short secondary ribs across the median belt of venter.

GK. H5592 from the same loc. Ik 1052 figured by MATSUMOTO *et al.* (1969, pl. 34, figs. 1a-b) has more complete outer whorl, in which large ventrolateral horns stretch sideward, giving a wing like feature. It is nearly as large as STOLICZ-

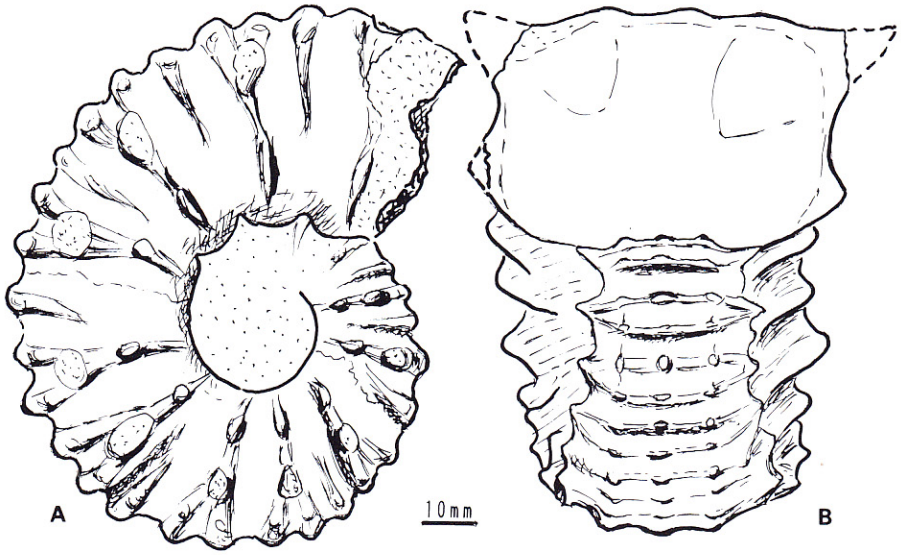

Fig. 7 *Cunningtoniceras meridionale* (STOLICZKA). Lectotype, GSI. 175, from S. India. (T.M. *delin.*)

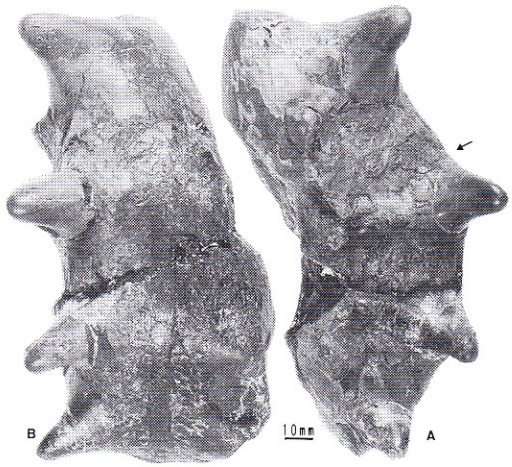

Fig. 8 *Cunningtoniceras* cf. *meridionale* (STOLICZKA). YCM-GP 731, collected by T.S. from loc. S208, Hakkin-zawa, Oyubari area.

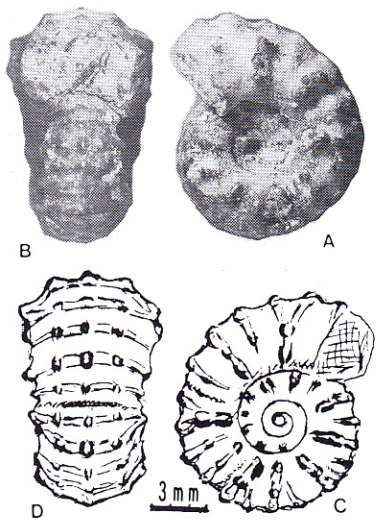

Fig. 9 *Cunningtoniceras meridionale* (STOLICZKA). GK. H8333, early immature specimen collected by A. TOMITA from the Ikushumbets section.

KA's largest specimen.

YCM-GP 731 (Fig. 8) is a fragmentary outer whorl, with poorly preserved external mould of the venter of the next inner whorl. Its two thirds are still septate and the rest is the beginning of the body chamber. On the ground of the observable characters this specimen is probably an outer whorl of this species. Because of the incomplete preservation we should call it *Cuningtoniceras* cf. *meridionale*.

In all the above specimens from Hokkaido, the sutures are of *Acanthoceral-Cunningtoniceras* pattern. STOLICZKA's (1864, pl. 41, fig. 1c) illustration of suture is essentially correct.

Here is a tiny but well preserved specimen, GK.

H8333 (Fig. 9), collected by Akio TOMITA from the sandstone (probably IIb of the Mikasa Formation) in the Ikushumbets section and donated to GK through Takemi TAKAHASHI and T.M. It is only 12 mm in diameter, but its outer whorl shows the characters which are quite similar to those of the lectotype. Minor differences are that the ventral part is broadly arched and therefore the inner ventrolateral tubercles are located nearly at the middle of flank and accordingly closer to the umbilical tubercles. Also some, if not all, of the intercalated ribs may have small inner ventrolateral tubercles. These differences are probably due to change with growth-stage, that is ontogenetic. At least two shallow, incipient constrictions are also discernible at D=10 mm and 8mm. In the next inner whorl, about 210° earlier than the beginning of the outer whorl, node like ribs begin to appear on middle to outer flank, from which the umbilical and inner ventrolateral tubercles are soon differentiated.

In view of the essential similarity to the middle-aged lectotype and also in comparison with somewhat larger immature shells described already (MATSUMOTO *et al.*, 1969, pl. 33, figs. 1b-d, 2a-c), we regard this small specimen as representing an early immature stage of *C. meridionale*.

Dimensions: See Table 4.

Remarks: Recently *C. meridionale* has been regarded as a variety or a subspecies of *C. cunningtoni* (e.g. ZABORSKI, 1985; WRGHT and KENNEDY, 1987), but this may have come from the misleading illustrations by STOLICZKA (1864, pl. 41, fig. 1, 1a, 1b). The whorl of *C. cunningtoni* is described as much depressed with a broad venter by some authors, but the precise measurements of the holotype and several other examples do not show a great value of B/H (see Table 4), being smaller than that of *C. lonsdalei*, as we have already pointed out. *C. meridionale* has much larger ritio of B/H (see Table 4). There is of course some variation in this character in both species and a few specimens may show an apparently intermediate feature with respect to this character.

The presence of secondary flank ribs, spinosity of the tubercles and the periodic constrictions in the middle or earlier growth-stage are, in our view, good criteria which enable us to distinguish *C. meridionale* from *C. cunningtoni*. Although the abult body chamber is not preserved in the lectotype, those in some specimens from Hokkaido show laterally stretched wing like ventrolateral horns on the major ribs and the bluntly elevated, mid-ventral bullae on the interspaces.

Occurrence: The lectotype is recorded to occur

Table 4. Measurements on selected specimens of *C. meridionale* and *C. cunningtoni*.

Specimen, position	D	U	H	B	B/H	H/h	R/2
C. meridionale, large one*	230.0 (1)	(.27)	(.44)	—	1.50	—	—
LT, E (ic)	97.0 (1)	31.0 (.32)	39.0 (.40)	55.0 (.57)	1.40	1.44	6/17
LT, E-90° (ic)	76.0 (1)	24.0 (.32)	31.0 (.41)	45.0 (.59)	1.45	1.48	6/15
C. cf. *m.*, YCM-GP 731 (ic)	—	—	47.0	64.0	1.36	—	5(?)
C. m., GK. H5612 (ic)	—	—	45.0	65.0	1.44	—	6(?)
inner whorl	56.7 (1)	16.8 (.30)	24.5 (.43)	36.0 (.63)	1.47	1.59	7/19
C. m., GK. H8333, E (c)	12.2 (1)	3.2 (.26)	5.2 (.43)	7.7 (.63)	1.48	1.37	5
C. cunningtoni, HT, LS (ic)	135.0 (1)	45.0 (.33)	52.0 (.38)	60.0 (.44)	1.15	1.37	5
ZAB. '85, f. 48 (ic)	110.0 (1)	42.0 (.38)	39.0 (.35)	41.0 (.37)	1.05	1.24	5
KOSSM. '97, pl. 5 (ic)	160.0 (1)	56.0 (.35)	63.0 (.39)	70.0 (.44)	1.11	1.54	6

*after STOLICZKA (1865, p. 76), LT=lectotype, HT=holotype, ZAB.=ZABORSKI, KOSSM.=KOSSMAT.

in the middle part of the Ootatoor [Utatur or Uttattur] Group at Odium [Odiyam], Trichinopoly [Tiruchirappalli] district of South India, without mentioning further details of stratigraphic position. It should be somewhere in the Cenomanian.

GK. H5612 was acquired by K. MURAMOTO at loc. Ik 1052 from the greenish grey sandstone bed of the Lower Member (IIb) of the Mikasa Formation on the eastern wing of the Ikushumbets anticline. This bed contains *Cunningtoniceras tatahashii* and is immediately below the greenish dark grey, silty fine-grained sandstone with *Calycoceras* (*Newboldiceras*) *orientale* and *Cunningtoniceras amphibolum*. It is certainly Middle Cenomanian. GK. H5592 (MATSUMOTO *et al.*, 1969, pl. 34) was obtained by M. WADA in 1958, when he was a student of Mikasa High School, from a fall from the same sandstone as above at loc. Ik 1052. An immature specimen GK. H5613 (op. cit. pl. 33, fig. 2) was found by T. TAKAHASHI from loc. Ik 1103, immediately below the sandstone characterized by *Cal.* (*Newboldiceras*) *asiaticum* (JIMBO) on the western wing of the Ikushumbets anticline. Thus the specimens from the Ikushumbets section are all referred to the Middle Cenomanian.

C. cf. *meridionale* from the Hakkin-zawa section of the Oyubari area is also Middle Cenomanian, for GMH. 12438 is associated with *Cun. lonsdalei* and *Turrilites costatus* and YCM-GP 731 was obtained at a level 20 m below the bed with *Cal.* (*Newboldiceras*) *newboldi* in the outcrop of loc. S208.

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Place names (Letters in Japanese)
Hongo (本郷), Ikushumbets [Ikusunbetsu] (幾春別),
Teshio (天塩) (See also p. 14 in Part 1.)