

Further notes on the ammonoid genus *Parajaubertella* (Studies of Cretaceous Ammonites from Hokkaido and Sakhalin-LXXX)

TATSURO MATSUMOTO¹, KATSUJO YOKOI² and YOSHITARO KAWASHITA³

¹*c/o Department of Earth and Planetary Sciences, Kyushu University, Fukuoka, 812-81 Japan*

²*Kenbuchi, Kamikawa-gun, Hokkaido, 098-03 Japan*

³*2-179 Tomatsu-Chiyoda, Mikasa, Hokkaido, 068-21 Japan*

Received 26 January 1997 ; Revised manuscript accepted 31 July 1997

Abstract. On the basis of additional material, a revised diagnosis of *Parajaubertella kawakitana* Matsumoto, 1943 is given and *P. zizoh* sp. nov. is established. While the former is fairly large, the latter is small. The globose shell, consisting of much depressed whorls with a deep and narrow umbilicus and a subangular umbilical edge, occurs for a while in the ontogenetic development of *Parajaubertella*. In *P. kawakitana* this character occurs in an early substage (shell diameter from 5 mm to 35 mm), and is followed by a long-continued middle stage, whereas in *P. zizoh* it appears somewhat later and extends to an early part of the adult body chamber. The adult body chamber is characterized by the bandlike or low, foldlike, broad ribs separated by narrow grooves (= adult *sacya*-type ornament) in both species. Their common ancestor, if any, has not been found. On the basis of the characters of the two species, *Parajaubertella* is referred to the Gaudryceratidae instead of the Tetragnostidae. The two species occur commonly in the Lower Cenomanian, but the level of their first appearance has yet to be investigated.

Key words : Cenomanian, dimorphism, Gaudryceratidae, *Parajaubertella*, *P. kawakitana*, *P. zizoh*

Introduction

The ammonite genus *Parajaubertella* was established by Matsumoto (1943) under the family Gandryceratidae on a species from South Sakhalin and Hokkaido. Because of its peculiar characters and probably because of the too short description in the original paper, its systematic position has been interpreted in different ways by authors (e.g. Wright, 1957, Wiedmann, 1962a, b ; Murphy, 1967 ; Howarth, 1996).

P. kawakitana Matsumoto, 1943, the type species, was recently described in detail by Matsumoto (1995, p. 11-27, figs. 3-13) under the Gaudryceratidae, while the revised edition of the *Treatise on Invertebrate Paleontology*, Part L, vol. 4 (Cretaceous Ammonoidea) was under preparation. Matsumoto should have sent a preprinted copy of his manuscript to the editor, but regrettably he failed to do so. Howarth (1996, p. 8 in that revised edition) has assigned *Parajaubertella* to the subfamily Tetragnostinae of the family Tetragnostidae.

In this paper, *P. kawakitana* is redescribed in the light of additional material, and another new species is established on specimens we acquired from the Soeushinai area. To accommodate these two species, a revised diagnosis of *Parajaubertella* is given, along with some comments on the relationships between the species concerned.

We hope that this paper may settle the above systematic problem.

General remarks

Technical terms.—As to the morphological terms and their abbreviations, we follow those in the recently published paper by Matsumoto (1995, p. 7-9).

Repositories.—The specimens which are illustrated and/or measured in this paper are held in the following institutions or collections in the alphabetic order of their abbreviations ;

GK : Type Room, Department of Earth and Planetary Sciences, Kyushu University, Fukuoka

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

YKC : Yoshitaro Kawashita Collection, temporarily housed in his residence, but eventually to be transferred to some institutions or museums

Localities.—The localities (abbreviated as loc. in the description below) where the described specimens were acquired are indicated by numbers under the heading KY (collected by K.Y.), R (collected by T. Nishida and others) or YKC (collected by Y. Kawashita). Their sites are shown in the route maps of the recently published papers by Nishida *et al.*, (1996 ; 1997). They are all in the Soeushinai area of northwestern Hokkaido. As to the Cretaceous stratigraphy of that area, readers may refer to the same papers, in which the scheme by Hashimoto *et al.* (1965) is considerably revised. A few specimens supplied by Takashi Yoshida are from Hirotoni of the Monbetsu area, south-central Hokkaido.

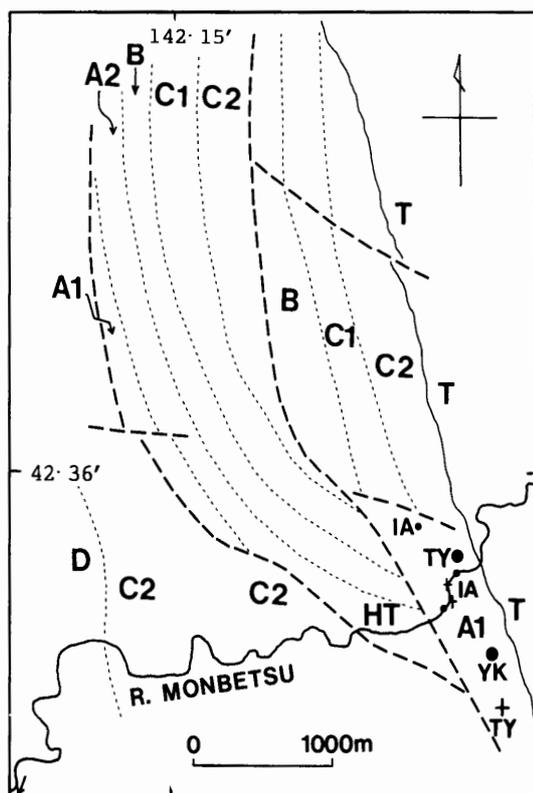


Figure 1. Geological sketch map of Hirotoni, Monbetsu area (courtesy of A. Inoma). The Upper Cretaceous is subdivided in ascending order from Units A1 (Lower Cenomanian) through A2, B, C, to D (Campanian) and overlain by a mid-Tertiary formation (T) with unconformity. A locality of early Cenomanian ammonite is indicated by a solid circle (in situ) or a cross-mark (transported). A solid circle with TY is BIU570228, and the one with YK is for *Sharpeiceras mexicanum*; cross-mark with TY is BIU570298 and others with IA are for *Desmoceras (Pseudouhligella) japonicum* Yabe etc. The location of the mapped area is indicated as M in the general map of Hokkaido by Matsumoto (1995, fig. 2).

Their localities are indicated under the heading BIU and are shown in Figure 1 of this paper.

Paleontological descriptions

Superfamily Tetragonitaceae Hyatt, 1900
 Family Gaudryceratidae Spath, 1927
 Genus *Parajaubertella* Matsumoto, 1943

Type species.—*Parajaubertella kawakitana* Matsumoto, 1943 by original designation (Matsumoto, 1943, p. 666).

Diagnosis (revised).—Shell typically large and fairly involute, but may be small in some species. Whorls at some ontogenetic stage much depressed, with broadly rounded venter, inflated flanks, subangular umbilical edge and fairly narrow and deep umbilicus, resulting in small but globose shell form. Whorl of late growth stage, including the adult body chamber, suboval or subrounded in section and provided with flat-topped or low foldlike, broad ribs separated by

narrow grooves as in those of adult *Anagaudryceras sacya* (Forbes) (Figure 2 and also Matsumoto, 1995, fig. 18). Lirae on the shell surface, periodic collars during growth and ribs of the adult body chamber subradial and gently flexuous on the flank and weakly or somewhat projected on the venter. Suture fundamentally similar to that of *Gaudryceras*, with formula E, L, U₂, U₁[=S], I. At the stage of small globose shell, the third lateral saddle situated on the umbilical edge.

Discussion.—One of us (Matsumoto, 1995, p. 10) has recently concluded that *Parajaubertella* is distinct from *Gabbioceras* Hyatt and that it is not a member of the subfamily Gabbioceratinae. Now, let us discuss the problem of whether it is more reasonable to ascribe *Parajaubertella* to the Tetragonitinae or to the Gaudryceratidae.

The suture of *Parajaubertella* is similar to that of *Eogaudryceras*, *Anagaudryceras* and *Gaudryceras* in the constituting elements, with a single main saddle in the internal part and symmetrically bifid saddles in the external part. That of Tetragonitinae has two or more internal saddles and asymmetric or even apparently tripartite saddles in the external part (see Wiedmann, 1962a, 1973; Matsumoto, 1959).

The type species and another new species of *Parajaubertella* are closely allied to *Anagaudryceras sacya* in having fine lirae on the surface of the outer shell layer and also the same type of ornament on the adult body chamber as described in generic diagnosis. In both genera the lirae, constrictions, collars and major ribs are gently flexuous on the flank and more or less weakly projected from the ventrolateral shoulder to the venter. In some individuals of *A. sacya* (Forbes) major ribs may appear for a short while at a middle growth stage as is illustrated by Kennedy and Klinger (1979, pl. 9, fig. 1) and shown by an example (Figure 2) from Hokkaido. This feature is somewhat similar to that of the middle-aged *P. kawakitana*.

In *Tetragonites* periodic constrictions and growth lines are generally prorsiradiate on the flank and more or less rursiradiate on the ventrolateral shoulder, crossing the venter with a weakly backward sinus. Howarth (1996, p. 8) attempted to compare *Parajaubertella* with *Takahashia* of the Tetragonitinae. The ribs of *Takahashia* Matsumoto, 1984 (p. 33, fig. 1) are rather rursiradiate on sides, crossing the venter with a backward sinus. They are analogous to those of a nautiloid genus *Cymatoceras* and not comparable with those of *Parajaubertella*.

These features evidently indicate that *Parajaubertella* belongs to the Gaudryceratidae.

Parajaubertella kawakitana Matsumoto, 1943

Figures 3–6

Synonymy.—See Matsumoto, 1995, p. 11.

Material.—The following specimens are added herein to the holotype and other specimens listed by Matsumoto (1995, p. 12): YKC610608 (Figure 3–2) obtained in situ at loc. R518 and YKC060823 (Figure 4) at loc. R521p, on the eastern branch of the Suribachi-zawa; YKC050609 from the Bishamon-zawa, YKC080621 (Figure 5) from loc. R909 of the Hotei-zawa; YKC080615 and YKC081029 from the upper

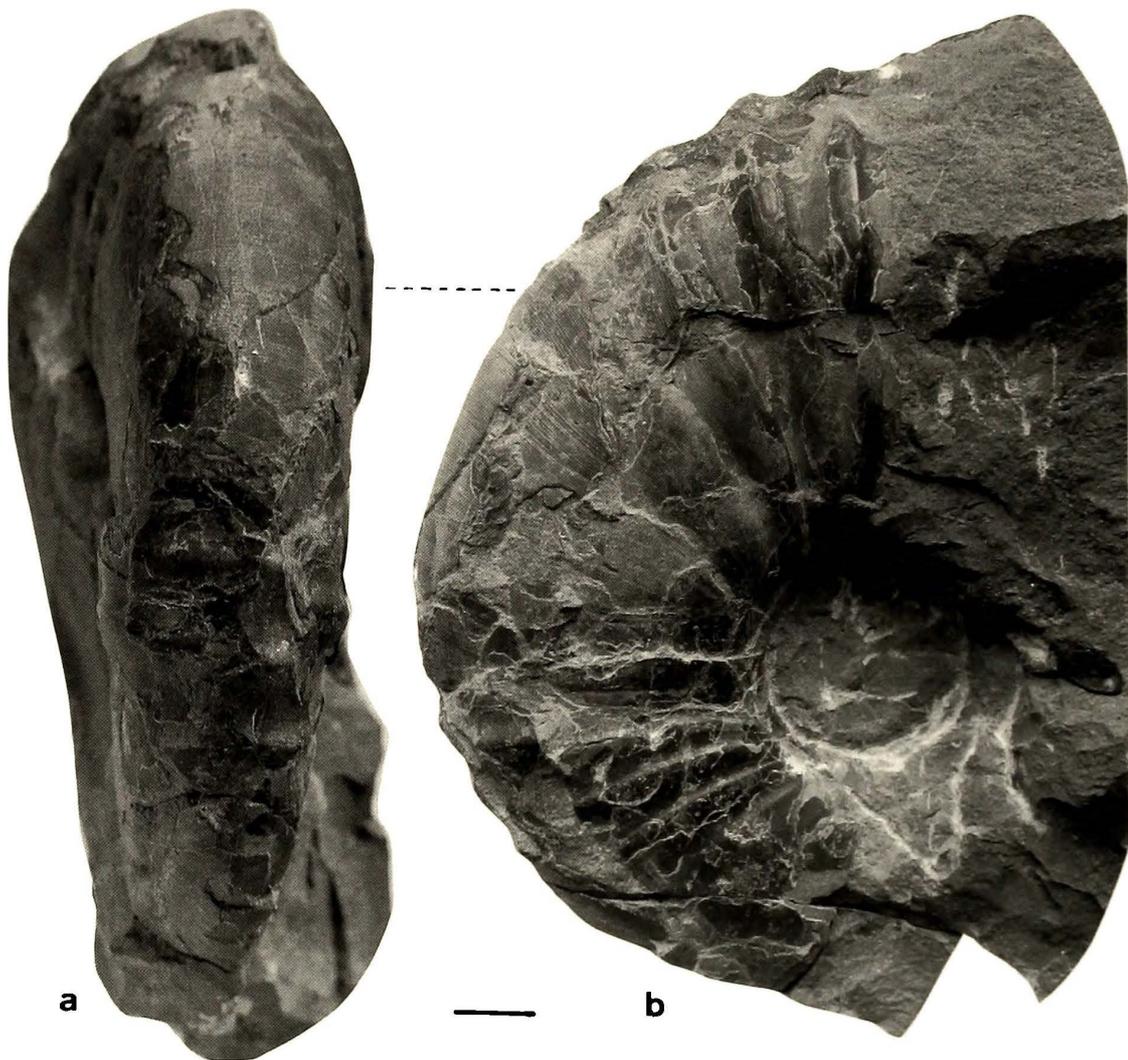


Figure 2. *Anagaudryceras sacya* (Forbes). YKC060825 from loc. R540p. Back (a) and side (b) views, x1. An example in which major ribs appear for a short while at a distance adapically from the typical adult *A. sacya* type ornament. Bar scale: 10 mm. (Photos by courtesy of Katsumi Shinohara.)

reaches of the Kyoiei-sakin zawa; these are all from Member My3 of the Soeushinai area. YKC080914 (Figure 3-1) from loc. R987p, lower part of My5, upper reaches of the Kotanbetsu River.

GK.H8479 (Figure 6) from loc. BIU570298, GK.H8480 and GK.H8481 from loc. BIU570228 [=BIU570235], near Hirotomi of the Monbetsu area, where an unnamed member of mudstone extends narrowly trending NNE-SSW along the Chennai-zawa, a branch rivulet of the Monbetsu River (see Figure 1).

Diagnosis.—Small shell of early growth stage globose, with narrow and deep umbilicus and depressed whorl section.

Whorl of middle growth stage long continued, showing gradual change from subrounded to suboval section and ornament of several rhythmic furrows occurring in periodic segments, where a constriction with associated collar and faint, incipient major ribs may sometimes appear. Adult shell large, about 200 mm diameter on average; its body chamber provided with the adult *A. sacya*-type ornament as described in the generic diagnosis.

Dimensions.—See Table 1.

Description.—The very young shell up to about 5 mm in diameter is similar to that of *Gaudryceras* and *Anagaudryceras* (see Matsumoto, 1995, fig. 5). The succeeding young

Figure 3. *Parajaubertella kawakitana* Matsumoto. **1a, b.** YKC080914, in a nodule obtained at loc. R987p. **2a, b.** YKC610608 from loc. R518 (in situ). Left lateral (a) and frontal (b) views, xl. In both specimens the body chamber is incomplete and secondarily compressed. Arrow mark indicates the position of the preserved last septum. Bar scale: 10 mm.



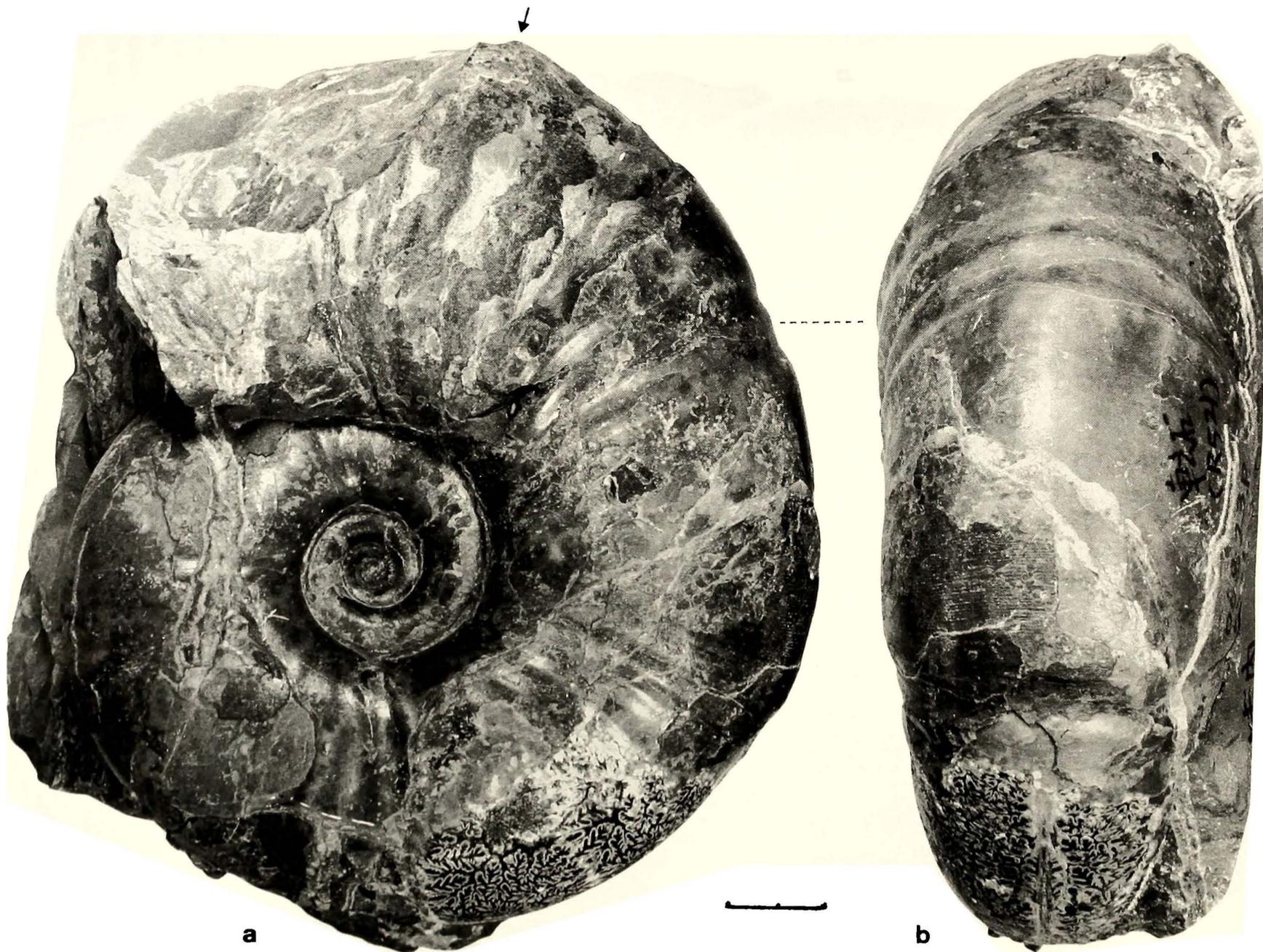


Figure 4. *Parajaubertella kawakitana* Matsumoto. YKC060823 from loc. R521p. Right lateral (a) and ventral (b) views of a nearly complete phragmocone, $\times 0.85$. Note the fine lirae on the shell surface where the outer shell layer is preserved and also the intricate suture where the test is taken out. Bar scale: 20 mm.

Table 1. Measurements of *Parajaubertella kawakitana*.

Specimen	D	U	U/D	H	H/D	B	B/D	B/H	H/h
YKC060823 (LS+45°)	171.0	43.0	.25	78.0	.46	—	—	—	—
" " (LS-45°)	145.0	35.0	.24	68.0	.47	66.0	.46	0.97	1.62
YKC610608	76.0	20.0	.26	35.0	.46	36.0	.47	1.08	1.67
Holotype (LS)	73.0	19.7	.27	33.6	.46	36.0	.49	1.07	1.71
GK. H8480 (E')	67.0	17.0	.25	30.0	.45	32.0	.48	1.07	1.50
" " (E'-180°)	—	—	—	20.5	—	23.0	—	1.12	—
GK. H8441	66.0	17.5	.27	31.0	.47	27.0	.44	1.07	—
YKC080914 (LS)	60.0	15.5	.26	28.0	.47	30.5	.51	1.09	1.70
GK. H8479 (E')	59.0	16.5	.28	26.5	.45	26.5	.45	1.00	1.66
" " (E-180°)	—	—	—	18.5	—	21.0	—	1.14	—
GK. H8478 (inner)	56.0	15.7	.28	25.5	.45	25.8	.46	1.01	—
UMUT. MM19699 (E)	28.5	7.8	.27	13.0	.48	20.0	.72	1.51	1.69

For other previously measured specimens, see Matsumoto, 1995, table 1.

D=diameter, U=width of umbilicus, H=whorl-height, B=whorl-breadth, h=whorl-height at half a whorl (*i.e.* 180°) adapical from H; E=preserved end, E'=near the preserved end; LS=last septum, LS'=immediately behind LS, E-180°=at half a whorl adapical from E. Measurements of linear dimensions are in mm.

shell with diameter to about 35 mm is globose, with much depressed whorl, subangular umbilical edge and narrow and deep, steplike umbilicus. This is well exemplified by the specimens previously illustrated by Matsumoto (1995, fig. 7A-D).

The middle growth stage continues for fully one whorl or more, with shell diameter from 35 or 40 mm to 100 or 130 mm in many cases, but there is a considerable size variation between individuals. Examples are shown in Matsumoto (1995, figs. 4, 9-11) and this paper (Figures 3-2, 4, 6). The shell of this growth stage is moderately involute, with a fairly narrow and moderately deep umbilicus; whorl expands with a fairly high ratio, but its cross section shows a gradual change from subrounded to suboval; in parallel to dense, subradial lines on the shell surface several rhythmic furrows occur in periodic segments; some of the furrows are deep enough to be called constrictions and accompanied behind by a weak collar or sometimes by faint, incipient major ribs.

The adult shell is fairly large; GK.H8456, obtained by Y.K. in the Suribachi-zawa of Soeushinai area and figured by Matsumoto (1995, fig. 13) represents the later half of a large body chamber, although in many cases the adult body chamber is partly preserved or distorted. The ornament of the adult body chamber is characterized by flat-topped, bandlike or low foldlike, broad major ribs with narrowly grooved interspaces. This is well observable even in partly preserved specimens (see Figures 3-1, 2; 6-1; also Matsumoto, 1995, figs. 4, 10, 11, 12).

Suture fundamentally similar to that of *Gaudryceras*; at the globose young stage the third lateral saddle inside of U₂ situated at the umbilical edge, with descending auxiliaries on the umbilical wall; incisions fairly deep even at this stage, becoming progressively more intricate with growth (see Figure 5; also Matsumoto, 1995, fig. 3d).

Discussion.—Based on the diagnostic characters, this species is presumed to have close affinities with some species of *Anagaudryceras*, although its direct ancestor has not been found in the hitherto described species. For the

reason of the peculiar characters of its globose immature shell, its separation in an allied but distinct genus is justified. The long-continued middle growth stage and the consequent large size of the adult shell are of specific rather than generic character.

The unusually small specimens as represented by YKC080914 (Figure 3-1) might be interpreted as a microconch of a dimorphic pair, but the evidence of sexual dimorphism is by no means sufficient. The apparent end of the septate stage does not always imply the beginning of the adult body chamber, as has been already explained (Matsumoto, 1995, p. 25). There is also considerable size variation as has been mentioned in the above description.

Occurrence.—The additional specimens came from the siltstone of Member My3 and lower part of Member My5 (Lower Cenomanian) of the Soeushinai area (see Nishida *et al.*, 1996; 1997) and also from the unnamed mudstone member at Hirotoni of the Monbetsu area. The latter is referred also to the Lower Cenomanian on the ground of *Sharpeiceris mexicanum* (Böse) obtained by Y.K. from it.

The specimens described previously are from Member Kx and Ky of the Kawakita Group in the mid-valley of the Naibuchi [Naiba], South Sakhalin; upper part of Member

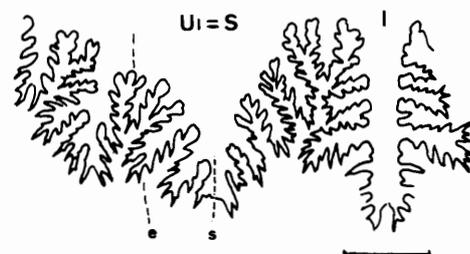


Figure 5. *Parajaubertella kawakitana* Matsumoto. Internal suture of YKC080621b8 from loc. R909. I: internal lobe, U₁=S: first umbilical lobe situated at s. e: umbilical edge, s: umbilical seam. Bar scale: 10 mm.

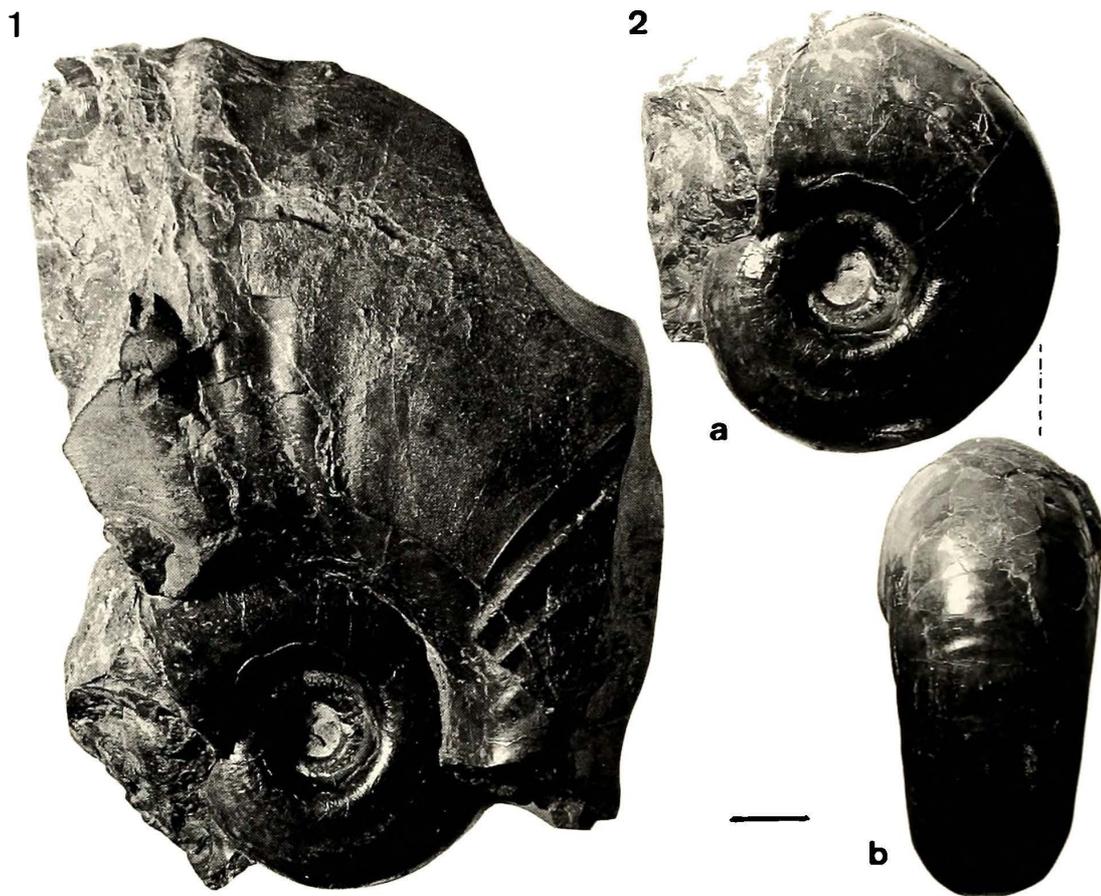


Figure 6. *Parajaubertella kawakitana* Matsumoto. GK.H8479 from loc. BIU570228 (T. Yoshida). 1: Right lateral view of the whole specimen in which outer whorl is incomplete; 2: Lateral (a) and ventral (b) views of the inner whorl, $\times 1$. Bar scale: 10mm.

lla of the Abeshinai-Saku area northern Hokkaido; Member My3 and lower part of Member My5 in the Soeushinai area; Members Ild and Ile of the Oyubari-Shuyubari area of central Hokkaido (Matsumoto, 1943, p. 667; 1995, p. 25). This species is, thus, common in the Lower Cenomanian of Hokkaido and South Sakhalin. It occurs also in the Chitina Valley of southern Alaska (Matsumoto, 1959 and Jones, 1967 under *P. imlayi*, which is a junior synonym of *P. kawakitana*), in the upper part of the Haida Formation of western British Columbia (McLearn, 1972), and in the Talovka Basin of western Korjak-Kamchatka (Alabushev, 1995).

The above records indicate that this species occurs commonly in the lower part of the Cenomanian, but its first and last datum levels have yet to be worked out.

***Parajaubertella zizoh* sp. nov.**

Figures 7-9

Material.—The holotype is GK.H8482 (Figure 7-4) contained in a nodule (loc. R575 pl) which had fallen directly

from the outcropping siltstone at loc. R575 of Member My3 on the right side of a small branch gully of the middle course of the Suribachi-zawa, a tributary of the River Sounnai. That locality was examined by Y.K. and T.M. The nodule contains *Marshallites rotundatus* Matsumoto and Takahashi among others. From another fallen nodule at a nearby locality, R575 p4, a specimen of *Graysonites* cf. *adkinsi* Young, YKC030728, was acquired by Y.K. In addition to the holotype, the specimens which show the adult body chamber at least partly are GK.H8445 (Figure 9-3) from loc. KY307, GK.H8446 (Figure 9-1) from loc. KY617, GK. H8447 (Figure 9-2), from loc. KY807, GK.H8485 (Figure 7-6) from loc. R518 p5 and YKC060619 (Figure 7-5) from the Bishamon-zawa, a branch of the Nakamata-zawa.

Among the phragmocones, mostly without body chamber, measured specimens are GK.H8484 (loc. R518 p5), GK. H8486 (Figure 7-2) (loc. R519 p2), GK.H8487 (Figure 7-3) (loc. R567p) and YKC050610. GK.H8488 and YKC060825 were collected *in situ* at loc. R456a and R575, respectively. GK. H8489 (Figure 7-1) from R519 p3 is tiny but shows fairly intricate sutures. The above specimens are all from Mem-



Figure 7. *Parajaubertella zizoh* sp. nov. **1a-d.** GK.H8489 from loc. R519p3 (four views of a juvenile). **2a-d.** GK.H8486 from loc. R519p2 (four views of a distorted phragmocone). **3.** GK.H8487 from loc. R567p; left lateral (a) and ventral (b) views of an incomplete specimen that represents last part of phragmocone and early part of body chamber. **4.** GK.H8482 (holotype) from loc. R575p in four views, i.e. left side (a), front (b), right side (c) and back (d). **5.** YKC060619, from the Bishamon-zawa, showing right side (a), venter (b) and cross-section (c). **6.** GK.H8485 from loc. R518p5; right side (a), venter (b) and left side (c) of body chamber. *Marshallites* sp. crops out along a fissure. All from Member My3 of Soeushinai area. The views of a-d in 1 and 2 are similar to those in 4. All $\times 1.2$. Bar scale: 10 mm.

Table 2. Measurements of *Parajaubertella zizoh*.

Specimen	D	U	U/D	H	H/D	B	B/D	B/H	H/h
GK. H8445 (LS+180°)	59.5	16.5	.28	27.5	.46	30.0	.34	1.09	1.77
" " (LS')	38.5	10.5	.27	18.0	.48	22.5	.58	1.25	—
GK. H8446 (LS)	39.0	10.6	.27	17.0	.44	19.6	.58	1.15	—
GK. H8482 (E')	34.0	10.7	.31	14.7	.43	—	—	—	—
" " (LS)	24.0	7.7	.32	9.2	.38	14.6	.61	1.59	1.42
YKC060619 (LS)	—	—	—	11.0	—	16.8	—	1.53	—
GK. H8447 (LS')	—	—	—	10.4	—	15.2	—	1.46	—
GK. H8484	22.4	7.2	.32	8.2	.37	12.6	.56	1.54	1.11
GK. H8486	17.8	6.0	.34	6.6	.37	9.4	.53	1.42	1.27
YKC050610 (E)	17.0	5.8	.34	7.2	.42	10.0	.59	1.39	—

Abbreviations as for Table 1.

ber My3 of the Soeushinai area, except for GK.H8445.

Diagnosis.—Shell small, normally about 40 to 45 mm in diameter and not exceeding 70 mm even in extreme cases. Whorls in the main growth stage depressed, with fairly narrow and deep umbilicus, becoming subrounded in section in the adult body chamber. Broad, flat-topped major ribs of *Anagaudryceras sacya* type appears earlier at diameter of 30 mm.

Dimensions.—See Table 2.

Description.—Early whorls less than 10 mm diameter are reniform in section. In the succeeding main part of the septate stage, the whorl is much broader than high, with broadly arched venter, much inflated flanks and fairly deep umbilicus.

The umbilical ratio (U/D) is somewhat variable (see Table 2). This may be due partly to the effect of secondary deformation, but in general the ontogenetic change is noted, namely, the umbilicus is moderately wide in youth and becomes fairly narrow later. At the substage with shell diameter about 20 to 25 mm, the umbilicus is fairly deep and encircled by a nearly vertical or slightly overhanging, high wall. At this substage the whorl is broadest at the inner end of the flank, showing the ratio B/H about 1.5 (± 0.1), and then, the flank slopes down for a short distance to the subangular edge of the umbilicus.

In the septate stage fine and dense lirae are discernible on the surface of the outer shell layer; constrictions are infrequent, except for several approximated ones on the last portion of the phragmocone.

The ornament of the adult body chamber is characterized by more or less wide, bandlike or low but asymmetrically wavy major ribs, with narrowly grooved interspaces. They are gently flexiradiate on the flank and somewhat projected on the venter. The lirae on the external surface of the body chamber are fine or very fine, showing some variation in density.

For some reasons the adult body chamber is often incompletely preserved, but its length can be estimated from the trace of the umbilical seam. The size of the complete adult shell, thus measured, is generally 40 to 45 mm in diameter.

Only one specimen, GK.H8445 (Figure 9-3), with an original diameter of 70 mm, is exceptionally larger than that. It was obtained from a transported nodule at locality KY307, which is a considerable distance from the other localities. It may have been derived from some part of Member My5, which is fairly higher than My3 but still somewhere in the Cenomanian. That specimen is, however, referred to this species at least provisionally, because it shows nearly all the specific characters described above.

The suture is as for the genus, following the fundamental pattern of *Anagaudryceras* and *Gaudryceras*. In the late septate stage, with shell diameters from 25 to 30 mm, the middle of U₂ is situated at about the point of maximum whorl breadth and the "third saddle" (here called for the sake of convenience) is at the umbilical edge, with somewhat but not much broadened stem; the auxiliaries are descending on the umbilical wall (Figure 8).

Specific name.—It is taken from Zizoh-Bosatsu in Japanese, i.e., Ksitigarbha in Sanskrit, a Buddhist deity often represented by a small statue and worshipped by country people.

Discussion.—On the grounds of the specific characters described above, this species is certainly assigned to *Parajaubertella*. It is, however, much smaller than *P. kawakitana*. In *P. zizoh* the long continued middle growth stage of the

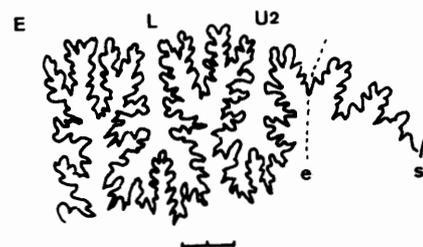


Figure 8. *Parajaubertella zizoh* sp. nov. External suture of GK.H8487 (Figure 7-3) at H=10.8, B=16.0. E: external lobe, L: lateral lobe, U₂: second umbilical lobe, e: umbilical edge, s: umbilical seam. Bar scale: 2 mm.



Figure 9. *Parajaubertella zizoh* sp. nov. **1a-d.** GK.H8446 from loc. KY617 (four views of an adult specimen). **2.** GK.H8447 from loc. KY807; ventral (a) and lateral (b) views of an incomplete specimen, in which the last part of the phragmocone is well-preserved, with sutures partly exposed, but the body chamber is much distorted and incomplete. **3.** GK.H8445 from loc. KY307; ventral (a), left side (b), sectional (c) and right side (d) views. It is exceptionally large for this species. All $\times 1.2$. Bar scale: 10 mm. (Photos in Figures 3, 4, 6, 7 and 9 by courtesy of Naoko Egashira.)

latter is omitted and a gradual change of whorl shape and ornament does not occur. As maturity comes early in *P. zizoh*, the adult body chamber is still somewhat broader than high, although it is subrounded in the late part. In adult *P. kawakitana* the whorl section is suboval and higher than broad. Even in youth the two species can be discriminated; specifically the young shell of *P. zizoh* has a wider umbilicus than does *P. kawakitana* (see U/D in Tables 1 and 2).

It might be claimed that small specimens of *P. zizoh* are merely microconchs of *P. kawakitana*. In the case of a sexual dimorphic pair, however, the morphological differences between the paired shells are normally minor in early growth stages and become clearer later, with much distinction in the adult. The observed young shells of *P. zizoh* show a dissimilar shape from those of *P. kawakitana*. We are, hence, inclined to deny the idea of regarding *P. zizoh* and *P. kawakitana* as a dimorphic pair of one species.

Furthermore, in the hitherto described species of Gaudryceratidae there are little or almost no examples of undoubted dimorphic pairs. There should be of course anatomical differences between males and females in this ammonoid group. *Gaudryceras denseplicatum* (Jimbo) and *G. intermedium* Yabe were once interpreted as a sexual dimorphic pair (Hirano, 1978). As Matsumoto (1995, p. 116) has recently commented, this interpretation is unnatural, if not impossible, because the two species do not have the same stratigraphic range, although their ranges partly overlap, and because they show dissimilar styles of ornament from a fairly young stage onward. On the contrary, no noticeable difference in the shell is recognized between a number of couples of one species, as exemplified by *Anagaudryceras limatum* (Yabe) (see Matsumoto, 1995, p. 53, 62, fig. 31).

In these circumstances and for the reason mentioned above, we regard for the moment *P. zizoh* as specifically distinct from *P. kawakitana* (see also discussion under that species).

As another possible interpretation, the above comparison seems to suggest that *P. zizoh* may be a result of acceleration of heterochronic shell growth and that *P. kawakitana* may exemplify retardation. We have found yet no common ancestor which could give rise to such evolutionary differentiation.

So far as the early substage (about 10 mm diameter) is concerned, *P. zizoh* appears to be similar to certain species of *Anagaudryceras*. In later growth stages *P. zizoh* has a deeper and narrower umbilicus surrounded by a more angular edge and a broader whorl, as compared with any known species of *Anagaudryceras*.

There are two incomplete specimens collected at locs. R527 and R302 from the Upper Albian Member My2 of the Soeushinai area. Regrettably they have lost their septate whorls, but their body chamber resembles that of *P. zizoh* in size, shell shape and ornament. Hence they could be referred to *P. zizoh* with a query or cf.. There are, however, small adult specimens which have been reported under *Anagaudryceras sacya* from the Albian of South Africa (see Kennedy and Klinger, 1979, pl. 10, figs. 3, 4). The latter does not show a depressed whorl or globose shell shape of

Parajaubertella fashion. The two specimens mentioned above might be merely fragmentary body chambers of a small form of *Anagaudryceras*. In *A. sacya*, which is long ranging, the variation in size seems to be considerable, but dimorphic pairs of this species have not been reported with sufficient evidence.

If the general shell shape alone is considered, *P. zizoh* appears to be similar to some small examples of certain species of *Tetragonites*, e.g., a form of *T. rectangulatus* Wiedmann (1973, pl. 7, figs. 1, 2) or that of *T. balmensis* Breistroffer (see Wiedmann, 1973, pl. 7, fig. 3), but this is quite superficial. *P. zizoh* has sutural elements which are the same as those of *Gaudryceras* and *Anagaudryceras*. In *Tetragonites*, constrictions normally have a backward sinus on the venter (see also the general discussion of the genus).

We have found some examples of *Gabbioceras* sp. from Member My3 of the Soeushinai area and correlatable units of other areas, although we do not intend to describe that species definitively on this occasion. It is small, about 25 mm in diameter at the beginning of the adult body chamber, and much globose. It seems to be similar to *G. yezoense* Shigeta, 1996 in shell shape. It has more depressed whorls and a narrower umbilicus as compared with *P. zizoh*. It has periodic constrictions accompanied behind by well raised flares, which are rursiradial on the outer flank and show a slightly backward sinus as in *Tetragonites*. Its internal suture has U_1 between I and $U_3=S$. Its well preserved specimens have riblets at rhythmic intervals around the umbilicus but do not show the lirae of *Anagaudryceras*. The body chamber, which is preserved under crushed state in some specimens, does not show adult *A. sacya* type ribbing. Thus, this species of *Gabbioceras*, can be clearly distinguished from *P. zizoh*. We are inclined to refer this *Gabbioceras* sp. to the Tetragonitidae. The similarity between *P. zizoh* and *Gabbioceras* sp. can be stated as an example of homeomorphy, though within the same superfamily Tetragonitaceae.

Occurrence.—As for Material. Even in the case of the fallen or transported nodules, the examined specimens came almost certainly from the fine-sandy siltstone of Member My3, Lower Cenomanian Zone of *Graysonites adkinsi* of the Soeushinai area, as is evidenced by the sites of localities also by some associated species (see Nishida *et al.*, 1996). One exceptional specimen is presumed to have been derived from Member My5.

To know the true stratigraphic range and geographic distribution of this species, further investigations are required.

Acknowledgments

We thank Tamio Nishida of Saga University, Yuko Kyuma and Naoko Egashira for their cooperation with us in the stratigraphic field work of the Soeushinai area in 1988, 1994 and 1995. Thanks are extended to Takashi Yoshida, former member of the Geological Survey of Japan, for his generous donation of the specimens from the Monbetsu area to Kyushu University with necessary information. In response to our inquiry, Akitoshi Inoma gave us valuable comments about the geology of that area. We are much indebted to C.

W. Wright (Beamster, England) for his kindness in reading an earlier draft with interesting suggestions. Egashira furthermore helped us in technical aspects and Kazuko Mori assisted us in preparing the manuscript.

References cited

- Alabushev, A., 1995: Ammonite faunas and biostratigraphy of the Albian to Middle Cenomanian (Cretaceous) in western Korjak-Kamchatka, NE Russia. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, vol. 196, p. 109-139.
- Hashimoto, W., Nagao, S. and Kanno, S., 1965: Soeushinai. *Explanatory Text of the Geological Map of Japan, scale 1: 50,000*, p. 1-92, quadrangle map. Geological Survey of Hokkaido. (in Japanese with English abstract)
- Hirano, H., 1978: Phenotypic substitution of *Gaudryceras* (a Cretaceous ammonite). *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, no. 109, p. 235-258, pls. 33-35.
- Howarth, M.K., 1996: Superfamily Tetragnonitaceae Hyatt, 1900. In Wright, C.W. with Callomon, J.H. and Howarth, M.K., *Treatise on Invertebrate Paleontology*, Part L, Mollusca 4, Revised, vol. 4: Cretaceous Ammonoidea, p. 2-9. The Geological Society of America, Boulder, and the University of Kansas, Lawrence.
- Jones, D.L., 1967: Cretaceous ammonites from the lower part of the Matanuska Formation, southern Alaska. *United States Geological Survey, Professional Paper*, vol. 547, p. i-v, 1-49, pls. 1-9.
- Kennedy, W.J. and Klinger, H.C., 1979: Cretaceous faunas from Zululand and Natal, South Africa. The ammonite family Gaudryceratidae. *Bulletin of the British Museum (Natural History) [Geology]*, vol. 31, no. 2, p. 121-174.
- Matsumoto [=Matumoto], T., 1943: A note on the Japanese ammonites belonging to the Gaudryceratidae. *Proceedings of the Imperial Academy of Japan, Tokyo*, vol. 18, no. 10, p. 666-679.
- Matsumoto, T., 1959: Cretaceous ammonites from the upper Chitina Valley, Alaska. *Memoirs of the Faculty of Science, Kyushu University, Series D*, vol. 8, no. 3, p. 49-90, figs 1-16, pls. 12-29.
- Matsumoto, T., 1984: A new tetragnonitid ammonite from Hokkaido. *Proceedings of the Japan Academy*, vol. 60, Ser. B, no. 3, p. 33-35.
- Matsumoto, T., 1995: Notes on gaudryceratid ammonites from Hokkaido and Sakhalin. *Palaeontological Society of Japan, Special Papers*, no. 35, p. i-vi, 1-152, frontispiece, figs. 1-70.
- McLearn, F.H., 1972: Ammonoids of the Lower Cretaceous sandstone member of the Haida Formation, Skidegato Inlet, Queen Charlotte Islands, western British Columbia. *Geological Survey of Canada, Bulletin*, vol. 188, p. 1-77, pls. 1-45.
- Murphy, M.A., 1967: The ammonoid subfamily Gabbioceratinae Breistroffer. *Journal of Paleontology*, vol. 41, p. 595-607, pl. 64.
- Nishida, T., Matsumoto, T., Kawashita, Y., Egashira, N., Aizawa, J. and Ikuji, Y., 1997: Biostratigraphy of the middle part of the Cretaceous Yezo Group in the Soeushinai area of Hokkaido—with special reference to the transitional part from Lower to Upper Cretaceous: Supplement—*Journal of the Faculty of Culture and Education, Saga University*, vol. 1, no. 1, p. 295-337. (in Japanese with English abstract)
- Nishida, T., Matsumoto, T., Yokoi, K., Kawashita, Y., Kyuma, Y., Egashira, N., Aizawa, I., Maiya, S., Ikuji, Y., and Yao, A., 1996: Biostratigraphy of the Cretaceous Middle Yezo Group in the Soeushinai area of Hokkaido—with special reference to the transitional part from Lower to Upper Cretaceous. *Journal of the Faculty of Education, Saga University*, vol. 43, no. 1, part 2, p. 63-147. (in Japanese with English abstract)
- Shigeta, Y., 1996: The genus *Gabbioceras* (Ammonoidea, Gaudryceratidae) from the Upper Cretaceous of Hokkaido, Japan. *Bulletin of the National Science Museum, Tokyo, Series C*, vol. 22, p. 1-9.
- Wiedmann, J., 1962a: Ammoniten aus der Vascogotischen Kreide (Nordspanien). I. Phylloceratina, Lytoceratina. *Palaeontographica, Abteilung A*, vol. 118, p. 119-237, pls. 8-14.
- Wiedmann, J., 1962b: Die Gabbioceratinae Breistroffer. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, vol. 115, p. 1-43, pls. 1-2.
- Wiedmann, J., 1973: The Albian and Cenomanian Tetragnonitidae (Cretaceous Ammonoidea), with special reference to Circum-Indic species. *Eclogae Geologicae Helvetiae*, vol. 66, p. 585-616, pls. 1-8.
- Wright, C.W., 1957: In, Moore, R.C. (ed.), *Treatise on Invertebrate Paleontology*. Part L, Mollusca 4, Cephalopoda, Ammonoidea. p.i-xxii, 1-490, figs 1-558 [passim]. Geological Society of America, New York, and University of Kansas, Lawrence.

Abeshinai アベシナイ, Bishamon-zawa 毘沙門沢, Biu 比宇, Chennai-zawa チェンナイ沢, Fukuoka 福岡, Hirotoni 広富, Hokkaido 北海道, Hotei-zawa 布袋沢, Kamikawa-gun 上川郡, Kawakita 川北, Kenbuchi 剣淵, Kotanbetsu 古丹別, Kyoei-sakin-zawa 共栄砂金沢, Mikasa 三笠, Monbetsu 門別, Naibuchi 内淵, Nakamata-zawa 中股沢, Oyubari 大夕張, Saga 佐賀, Saku 佐久, Sanjussen-zawa 三十線沢, Shumarinai 朱鞠内, Shuyubari 主夕張, Soeushinai 添牛内, Sounnai 早雲内, Suribachi-zawa スリバチ沢, Tomatsu-Chiyoda 唐松千代田
