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

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Abstract. On the basis of additional material, a revised diagnosis of *Parajaubertella kawakitanaka* Matsumoto, 1943 is given and *P. zizoh* sp. nov. is established. While the former is fairly large, the latter is small. The globular 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. kawakitanaka* 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, fold-like, broad ribs separated by narrow grooves (= adult sacra-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 Tetragonitidae. 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. kawakitanaka*, *P. zizoh*

Introduction

The ammonite genus *Parajaubertella* was established by Matsumoto (1943) under the family Gaudryceratidae 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. kawakitanaka* 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 Ammonoida) 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 Tetragonitinae of the family Tetragonitidae.

In this paper, *P. kawakitanaka* 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. (1995) is considerably revised. A few specimens supplied by Takashi Yoshida are from Hirotomi of the Monbetsu area, south-central Hokkaido.
Ammonoid genus Parajaubertella

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, U, U, [=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 a symmetrically bifid saddles in the external part. That of Tetragonitinae has two or more internal saddles and a symmetric 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. kawakitanana.

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 kawakitanana 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 YKC606823 (Figure 4) at loc. R52ip, on the eastern branch of the Suribachi–zawa; YKCO50609 from the Bishamon–zawa, YKC080621 (Figure 5) from loc. R099 of the Hotel–zawa; YKC080615 and YKC081029 from the upper

Figure 1. Geological sketch map of Hitomoto, 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 (Pseudouhligiella) 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 Gabbioceratidae Spath, 1927
Genus Parajaubertella Matsumoto, 1943

Type species.—Parajaubertella kawakitanana 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, subovate or subrounded in section and provided with flat-topped or low foldlike, broad ribs separated by
reaches of the Kyoei sakin zawa; these are all from Member My3 of the Soeushinai area. YKC060825 (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 Hiratomi 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 2. Anagaudryceras sacya (Forbes). YKC060825 from loc. R987p. 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.)

Figure 3. Paraubertella kawakitana Matsumoto. 1a, b. YKC060914, in a nodule obtained at loc. R987p. 2a, b. YKC0610608 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. *Parahabillia* kawakitaensis Matsumoto, YK000023 from loc. RS28. Right lateral (a) and ventral (b) views of a nearly complete phragmocone. × 0.85. Note the fine rise 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.
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 increase 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 constricitions 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 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 YKC806914 (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 seprate 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 Hirotomi of the Monbetsu area. The latter is referred also to the Lower Cenomanian on the ground of Sharpeiceras 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

| Table 1. Measurements of Parajaubertella kawakitana. |
|-----------------|---|---|---|---|---|---|---|---|---|
| Specimen        | D  | U  | U/D| H  | H/D| B  | B/D| B/H| H/h|
| YKC060623 (LS = 45') | 171.0 | 43.0 | .25 | 78.0 | .46 | —  | —  | —  | —  |
| YKC060626 (LS = 45') | 145.0 | 35.0 | .24 | 68.0 | .47 | 66.0 | .46 | 0.97 | 1.62 |
| YKC060806 | 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 |
| YKC060914 (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 |
| 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.

Figure 5. Parajaubertella kawakitana Matsumoto. Internal suture of YKC060621b from loc. R909. I: internal lobe, U= S: first umbilical lobe situated at s. e: umbilical edge, s: umbilical seam. Bar scale: 10 mm.
lla of the Abeshina Saku area northern Hokkaido; Member My3 and lower part of Member My5 in the Soeoshinai 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 Chi’tina Valley of southern Alaska (Matsumoto, 1959 and Jones, 1967 under P. imlayi, which is a junior synonym of P. kawakitanana), in the upper part of the Haida Formation of western British Columbia (McLean, 1972), and in the Talovka Basin of western Koryak Kamchatka (Alabushin, 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, H4842 (Figure 7-4) contained in a nodule (loc. R575 p1) 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 Sounai. 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, YK030728, was acquired by Y.K. In addition to the holotype, the specimens which show the adult body chamber at least partly are GK, H4445 (Figure 9-3) from loc. KY307, GK, H4446 (Figure 9-1) from loc. KY617, GK, H4447 (Figure 9-2), from loc. KY307, GK, H4485 (Figure 7-6) from loc. R518 p5 and YKC060619 (Figure 7-5) from the Bishopon-zawa, a branch of the Nakamata-zawa.

Among the phragmococones, mostly without body chamber, measured specimens are GK, H4848 (loc. R518 p5), GK, H4846 (Figure 7-2) (loc. R519 p2), GK, H4847 (Figure 7-3) (loc. R567p) and YKC050610. GK, H4888 and YKC060825 were collected in situ at loc. R456a and R575, respectively. GK, H4849 (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 Bishamont 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 × 1.2. Bar scale: 10 mm.
Table 2. Measurements of *Parajaubertella zizoh*.

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<tr>
<th>Specimen</th>
<th>D</th>
<th>U</th>
<th>U/D</th>
<th>H</th>
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Abbreviations as for Table 1.

ber My3 of the Soeushina 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 middle 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 outer end of the shell, showing the ratio B/H about 1.5 (± 0.1), and then, the flanks 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 localitities. 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 U1 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. kawakitanana*. 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, U1: second umbilical lobe, e: umbilical edge, s: umbilical seam. Bar scale: 2 mm.](image-url)
Figure 9. *Paraaubertella* zizoh sp. nov. 1a-d. GK.H8446 from loc. KY817 (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 ×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 differentiated; 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 densepicatum (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. RS27 and R302 from the Upper Albian Member My2 of the Soeushina 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 saaya 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. saaya*, 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. rectangularis* Wiedmann (1973, pl. 7, figs. 1, 2) or that of *T. balmensis* Brostroffer (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 Gabbioeceras sp. from Member My3 of the Soeushina area and correlative 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 periodical constrictions accompanied behind by well raised flares, which are rursradiate on the outer flank and show a slightly backward sinus as in *Tetragonites*. Its internal suture has U- between I and u7=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. saaya* type ribbing. Thus, this species of Gabbioeceras, can be clearly distinguished from *P. zizoh*. We are inclined to refer this Gabbioeceras sp. to the *Tetragonitidae*. The similarity between *P. zizoh* and Gabbioeceras sp. can be stated as an example of homeomorphy, though within the same superfamly *Tetragonitaceaee*.

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 Soeushina 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.

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References cited


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. 16-18, 12-29.


