862. ADDITIONAL NOTE ON UPPER PERMIAN RADIOLARIAN FAUNA FROM ITSUKAICHI, WESTERN PART OF TOKYO PREFECTURE, CENTRAL JAPAN*

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Abstract. Well-preserved upper Permian radiolarians were recovered abundantly from a chert block embedded in the Unazawa Formation distributed in Kashihara, Itsukaichi Town, Tokyo Prefecture, central Japan. A part of this radiolarian fauna including the Families Entactinidae, Palaeoeactinomiidae, Palaeoscendidae and Phacodiscidae and the Superfamily Latentifistulidea has already been described by the present authors. This study is an addition to the continuing investigation of this fauna and several newly discriminated genera and species of Entactinidae, Tormentidae, Albalitellidae and Spumellaria incertae sedis are described. Among them, two genera Uberinterna and Triplanospongus and ten species are proposed as new to science.

This paper also attempts to compare the present radiolarian fauna with that of the Ultra-Tamba Belt of Southwest Japan and of the Delaware Basin of West Texas.

Introduction and acknowledgments

The study of the upper Paleozoic Radiolaria began with the classical works on the European Tethyan regions by Rüst (1892). Taxonomic works of the upper Paleozoic Radiolaria were resumed during the latter half of 1940's with investigation by Deflandre (e.g. 1946), and were followed by Foreman (1959, 1963) and Holdsworth (e.g. 1966, 1969) based on specimens separated from hard rocks by the hydrofloric or hydrochloric acid extraction method. Since the latter half of 1970's, the character of upper Paleozoic radiolarian fauna has been clarified in various areas of the world based on detailed observations with the use of a scanning electron microscope (Ormiston and Lane, 1976; Ormiston and Babcock, 1979; Won, 1983; Ishiga and Imoto, 1980; Ishiga et al., 1982b; Cheng, 1986; Gourmelon, 1987 and others). The upper Permian bilaterally symmetrical Radiolaria has been described by Takemura and Nakaseko (1981), Ishiga et al. (1982b), Ishiga and Miyamoto (1986), and Caridroit and De Wever (1986) from Southwest Japan. Recently, an abundant and well-preserved upper Permian polycystine fauna has been reported by De Wever and Caridroit (1984), Sashida and Tonishi (1985, 1986) and Caridroit and De Wever (1986). However, radiolarian faunas comparable to this Japanese Upper Permian fauna have not been recognized outside of Japan, except for the

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Guadalupian Albaillellaria (Ormiston and Babcock, 1979) and Spumellaria (Nazarov and Ormiston, 1985) from the Delaware Basin of West Texas. In this article, a three-fold subdivision of the Permian System is applied because of the popularity of such a usage among Japanese biostratigraphers.

This paper is the third report on the description of Upper Permian radiolarians from Itsukai-chi and several new genera and species of Entactiniidae and Spumellaria Incertae sedis as well as new species of Tormentidae and Albaillellidae are proposed from newly discriminated assemblages. The present authors also attempt to compare the present fauna with that of the Ultra-Tamba Belt of Japan and of the Delaware Basin of West Texas, U.S.A.

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Geologic setting

The present authors once assumed that a chert block yielding a rich Upper Permian radiolarian fauna is intercalated as a lenticular body within a shale facies of the Unit B of the Chichibu System (Sashida and Tonishi, 1985). The senior author recently restudied the geology of the Itsukaichi area. The following is a brief summary of geology in this area from the north to south (Fig. 1).

Figure 1. Index map of the fossil locality.
1) Mitsuzawa Formation (Takashima and Koike, 1984)

The Mitsuzawa Formation is mainly composed of a Lower to Middle Jurassic phyllitic shale including exotic blocks of chert and limestone. The total thickness of this formation is more than 700 m.

2) Fukazawa Formation (Takashima and Koike, 1984)

This formation consists mainly of a Middle Jurassic black shale and sandstone containing exotic blocks of chert and limestone. Its total thickness amounts to 800 m.

3) Unazawa Formation (Fujimoto, 1939; Takashima and Koike, 1984)

The Unazawa Formation consists mainly of chert, siliceous shale and sandstone, and a repetitive sequence of these lithologies by tectonic deformations is characteristic of this formation. A sequence consisting of chert, siliceous shale and sandstone, in ascending order, repeats six times in this formation. The senior author tentatively named these six sequences, Unit I to Unit VI, beginning with the northernmost one. A sandstone bed in the upper part of Unit IV intercalates a volcanioclastic layer containing limestone and chert blocks. The total thickness of the formation exceeds 2000 m.

4) Hikawa Formation (Fujimoto, 1939; Takashima and Koike, 1984)

This Upper Jurassic formation is characterized by the lower massive sandstone and the upper pebbly shale containing exotic blocks of chert and limestone. The total thickness of the formation is about 600 m.

5) Gozenyama Formation (Fujimoto and Suzuki, 1957; Takashima and Koike, 1984)

The Gozenyama Formation is Early Cretaceous in age and is composed of a phyllitic shale containing blocks of chert, limestone and volcanioclastic rocks of various sizes. This formation attains the total thickness of 1300 m.

6) Ozawa Formation (Takashima and Koike, 1984)

This Lower Cretaceous formation is composed of a phyllitic shale including small-sized sandstone blocks. The total thickness of this formation exceeds 400 m.

The six formations trend in a NW-SE direction and dip steeply northward. They are in contact with each other by northward-dipping, high-angled reverse faults.

The chert block containing the Upper Permian radiolarians described in this paper is intercalated within a volcanioclastic layer of Unit IV of the Unazawa Formation (Fig. 1). This volcanioclastic layer was formerly named the “Shiromaru Paleozoic Formation”, because it contains limestone blocks yielding Carboniferous to Permian fusulinids.

Sample and age

The chert block which bears Upper Permian radiolarians has a maximum diameter of about 10 m, and exhibits a synfold with a northwest-plunging axis at an angle of 45 degrees (Sashida and Tonishi, 1985, Fig. 2). This chert block comprises 130 individual layers of chert, each of which is separated by a thin film of mudstone, and these layers are altogether about 5 m thick. The present authors sampled every layers in this chert block. Of these rock samples A-4, -7, -8 and -12 contain abundant and well-preserved radiolarian specimens. In particular, those specimens from samples A-4 and A-7 are treated in this paper.

Samples A-4 and A-7 yield albaillellids such as Folliculites scholasiticus Ormiston and Babcock morphotype II Ishiga and Miyamoto, F. ventricosus Ormiston and Babcock, Albaillella levis Ishiga, Kito and Imoto, Neoalbaillella ornithoformis Takemura and Nakaseko, and N. grypus Ishiga, Kito and Imoto. The specific compositions of this albaillellid fauna is characteristic of the Neoalbaillella ornithoformis Assemblage-Zone which is the uppermost radiolarian zone in the Permian System of Southwest Japan (Ishiga, 1986b). Ishiga (1986b) estimated the geologic age of this assemblage zone to be late Late Permian.
Comparison of the Upper Permian radiolarian fauna of Itsukaichi with both the faunas of the Ultra-Tamba Belt of Southwest Japan and the Delware Basin of North America

In the Upper Permian radiolarian assemblages of Japan, two distinct groups are recognized based upon the specific composition and the lithofacies in which radiolarians are preserved. One assemblage is characterized by an association of albalillellids including Follicucullus scholasticus, F. ventricosus and some representative species of Neoalbaillella (e.g., N. optima, N. gracilis, and N. ornithoformis). This assemblage is characterized by the entire absence of F. bipartitus Caridroit and De Wever, F. hamatus Caridroit and De Wever, F. falx Caridroit and De Wever, and F. orthogonus Caridroit and De Wever. In the Ultra-Tamba Belt, this assemblage occurs in a clastic rock facies (Musashino et al., 1987), whereas it is usually recovered from a bedded chert facies of both the Mino-Tamba Belt and the Chichibu Belt of Southwest Japan. The other assemblage is dominated by the presence of Follicucullus hamatus, F. bipartitus, F. charveti, F. falx, F. orthogonus and by the absence of species of the genus Neoalbaillella. This assemblage is confirmed in clastic rocks or finely alternating beds of siliceous shale and black shale from the Kamigori and Tatsuno Formations of the Ultra-Tamba Belt (Caridroit and De Wever, 1984, 1986) and in similar lithologies in the Kurosegawa Belt of the outer zone of Southwest Japan (Ishiga and Miyamoto, 1986; Yamakita, 1986). Ishiga and Miyamoto (1986) named the latter Follicucullus bipartitus—F. charveti assemblage, and they considered that this assemblage is coeval with the radiolarian assemblage of the upper part of the Follicucullus scholasticus Assemblage Zone in the chert facies of Southwest Japan. However, the variety of species of the upper Permian radiolarian faunas from the chert facies is quite small except for the albalillellid. On the other hand, a rich radiolarian fauna composed of Entactiniidae, Latentifistulidea and Albalillellidae is reported from upper Permian clastic rocks of the Ultra-Tamba Belt (De Wever and Caridroit, 1984; Caridroit and De Wever, 1986). These authors described many species of Follicucullus, such as F. bipartitus, F. charveti, F. falx, F. orthogonus, F. hamatus, F. hamatus uncinatus, and F. scholasticus. Among them, F. scholasticus is the only species in common between the faunas of Itsukaichi and Ultra-Tamba Belt. Also, they erected a new families Deflandrellidae and Ormistonellidae in the Superfamily Latentifistulidea, and several new genera and species were introduced in Latentifistulidae. In these stauraxon polycystines, Ishigaum trifusis De Wever and Caridroit, Nazarovaella gracilis De Wever and Caridroit and Pseudotormentus kamigoriensis De Wever and Caridroit occur in both of the faunas. At the generic level, Deflandrella and Latentifistula are also in common between the two faunas. As already described by the present authors, the fauna of Itsukaichi contains rich and varied genera and species in the Family Entactiniidae. On the other hand, only four entactiniid species, such as Haplentactinia ichikawai Caridroit and De Wever, Entactinia sp., Entactinosphaera auboutini Caridroit and De Wever and E. echinata (Hinde) were described from the Ultra-Tamba Belt. However, there are no species of entactiniid in common between the two faunas. Caridroit and De Wever (1986) considered that the difference in the specific composition between those Upper Permian radiolarian faunas characterized by Neoalbaillella and those comprising varied species of Follicucullus resulted from the difference in lithofacies, diagenetic process, paleoenvironment and paleogeography. Ishiga (1986a) also stated that the radiolarian species of the Follicucullus bipartitus—F. charveti assemblage might have inhabited the ocean near the land because they are usually found in clastic rocks. Further investigations are necessary to confirm this problem by accumulating detailed field and faunal data.

Ormiston and Babcock (1979) were the first to describe two species of Follicucullus from the Permian Lamar Limestone of West Texas, North America. Later, Nazarov and Ormiston (1985) introduced rich Spumellarians from the Lamar

As stated earlier, our knowledge of the Upper Permian radiolarian taxonomy and Permian radiolarian biostratigraphy outside of Japan is quite insufficient, and we are now in the process of accumulating more data from North America, Europe, Russia, China and other areas. These data are hoped to solve the problems of paleobiogeography of radiolarians, inter-regional correlation of various radiolarian zones and depositional environments of radiolaria-bearing rocks.

**Systematic description**

In the following description, the morphological terminology for those species belonging to the Family Entactiniidae and the Superfamily Latentifistulidae, basically follows that of Nazarov and Ormiston (1985) and that of *Neoalbaillella* is adopted from Takemura and Nakaseko (1981) and Ishiga *et al.* (1982b). All the specimens described herein deposited in the collection of Institute of Geoscience, University of Tsukuba (IGUT).


Family Albaillellidae Deflandre, 1952

Genus *Neoalbaillella* Takemura and Nakaseko, 1981


*Neoalbaillella pseudogrypus* Sashida and Tonishi, n. sp.

Figures 9-1–6.

*Neoalbaillella grypus* Takemura and Nakaseko; Sashida and Tonishi, 1985, pl. 7, fig. 2.

**Diagnosis**: *Neoalbaillella* of bilaterally symmetrical shell with strongly curved apical cone and cylindrical pseudoabdomen having 3 to 4 horizontal rows of large square to rectangular windows.

**Description**: Apical cone imperforate, curves strongly to ventral side. Its apex sometimes curves downward. Pseudothorax and pseudo-abdomen cylindrical, with 4 to 5 horizontal rows of windows. Pseudothorax with dorsal and ventral triangular blade-like wings. Pseudo-abdomen with two rods, ventral and dorsal rods extending vertically downward and having 2 or 3 short spines projecting outwardly. Pore frames of shell wall arranged in 5 or more horizontal rows. Traveculae circular and lying on inner surface of shell wall. Each row of pore frames has 10 to 12 windows. Windows of upper 2 rows small, elliptical and those of center rows square to oblong. Pore frames of the upper first to fourth horizontally extended and touched with ventral wing. Usually, the second frame connected with Y-rods. Other frames adjoin lamellar-blade of ventral wing and rather large pores located between them. Shape of these pores trapezoidal at upper and middle parts. Lower edge of ventral wing connected with the fifth frame, making reverse trapezoidal pore. The fifth frame often
protrudes toward the same direction of Y-rod. Length of dorsal wing about two-thirds of ventral wing. X-rod of dorsal wing extends nearly perpendicularly to dorsal rod. Lamellar-blade of dorsal wing contacts dorsal rod and possesses 1 or 2 windows of circular to subcircular or triangular shape.

**Remarks:** This new species is similar to *Neoalbaillella grypus* Ishiga, Kito and Imoto in having a strongly bended apical cone. However, this new species is distinguishable from the latter by having longer pseudoabdomen and many windows of rectangular to oval shape. Moreover, this species has characteristic pores in the skirt of its ventral wing. *Neoalbaillella pseudogrypus*, n. sp. differs from other species of *Neoalbaillella* in its strongly curved apical cone.

**Measurements** (in μm): Length of shell body including apical cone, 250–271; maximum diameter of shell, 95–100; length of Y-rod at ventral wing, 142–214; maximum width of window, 25–36; maximum length of window, 25–29, based on 20 specimens.

**Etymology:** Combination of latin *pseudo* and species name *grypus*.

**Type:** Holotype, Fig. 9-1, sample, A-4, IGUT-KS0234: Paratypes, Fig. 9-2, sample, A-4, IGUT-KS0235; Fig. 9-3, sample, A-4, IGUT-KS0240; Fig. 9-4, sample, A-7, IGUT-KS0236; Fig. 9-5, sample, A-7, IGUT-KS0208; Fig. 9-6, sample, A-4, IGUT-KS0212.

Suborder Spumellaria Ehrenberg, 1875
Family Entactiniiidae Riedel, 1967
Tribus Entactiniini Nazarov, 1975
Genus Entactinosphaera Foreman, 1963

**Type species:** *Entactinosphaera esostrogyla* Foreman, 1963, Upper Devonian, Huron Member of the Ohio Shale, U.S.A.

Entactinosphaera pseudocimelia Sashida and Tonishi, n. sp.

Figures 7-1–3, 6–8.


**Diagnosis:** *Entactinosphaera* with 2 three-bladed major spines. Inner shell bearing rather short spines.

**Description:** Outer shell spherical with two major spines. Inner shell much smaller than outer one. Diameter of inner shell usually less than one-third to one-fourth that of outer shell. Inner shell with circular pores. Internal framework within inner shell not distinct in available material. Inner and outer shell united by a pair of massive, three-bladed cross-beams which thicken gradually away from inner shell and join with two major external spines. Numerous, thin, rod-like spines arising from inner shell. Some specimens (*e.g.* Fig. 7-8) have very long spines arising from inner shell, rarely contact with outer shell like a pair of cross-beam (Fig. 7-7). Wall of outer shell thin. Outer shell surface bears numerous acute ridges or partitions intersecting in disorganized manner to form polygonal cells. These cells separate groups of pores in numbers ranging from 1 to 4, most frequently with 2 pores per cell. Inner surface of outer shell smooth. Major spines usually three-bladed, rarely four-bladed, just like a bundle of 3 thin rods which gently tapers. Sometimes one of major spines displays torsion of about 60 degrees.

**Remarks:** This new species resembles *Entactinosphaera cimelia* Nazarov and Ormiston described from the Guadalupian Lamar Limestone of West Texas in the feature of ridges or partitions of the outer surface of the outer shell. However, this new species can be distinguished from the latter by having three-bladed major spines shaped like a bundle of 3 thin and gently tapering rods.

**Measurements** (in μm): Diameter of outer shell, 140–175; diameter of inner shell, 38–44; length of major spines, 71–143, based on 15 specimens.

**Etymology:** Combination of latin *pseudo* and species name *cimelia*.

**Types:** Holotype, Fig. 7-1, sample, A-4, IGUT-KS0320: Paratypes, Fig. 7-2, sample, A-4,
Entactinosphaera brevispinosa Sashida and Tonish, n. sp.

Figures 7-9–13.

Diagnosis: Entactinosphaera having a rather large outer shell with 0 to 6 short major spines and polygonal cells on outer surface of outer shell.

Description: Outer shell spherical with fewer than six major three-bladed spines. Inner shell small, thin-walled, penetrated by predominantly rounded pores. Diameter of inner shell less than one-fourth the outer shell. Internal framework within inner shell not distinct, but several very thin spicules present in available specimens. Numerous, thin and rod-like spines arising from inner shell. Inner and outer shells united by a pair of massive, three-bladed crossbeams with thicken rapidly away from inner shell and unit with two major external spines. In some specimens, one of rod-like spines from inner shell touches inner surface of outer shell. Wall of outer shell thin. Shell surface bears numerous acute ridges or partitions intersecting in disorganized manner to form polygonal cells. These cells surround groups of pores numbering from 1 to 5. Short major spines three-bladed, and not twisted. The number of spines variable. Length of major spines less than half the diameter of outer shell.

Remarks: This new species is characterized by having a rather large spherical outer shell and variable numbers of the short major spines. The number of major spines is an important criterion for the polycystine taxonomy. However, many kinds of radiolarian taxa which have inconsistent numbers of major spines in the same species were reported from the Paleozoic rocks. For example, Entactinosphaera crassicratatus Nazarov and Ormiston from the Guadalupian Lamar Limestone has 2 to 6 major spines. In the present collection, there are some specimens which either have rudimentary major spines or lack the spine entirely. In the latter case, these specimens have a tendency to develop an outer shell which bear cells surrounding only one pore. The present authors tentatively included these specimens in Entactinosphaera brevispinosa, n. sp. Those specimens of this new species having 6 major spines resemble Entactinosphaera crassispinosa Sashida and Tonish described from the same chert. However, the latter species has a smaller outer shell and thicker major spines than those of the former.

Measurements (in μm): Diameter of outer shell, 280–330; diameter of inner shell, 45–60; length of major spine, 60–105, based on 12 specimens.

Etymology: Latin brevis meaning short and spinous meaning short and spine

Types: Holotype, Fig. 7-9, sample, A-4, IGUT-KS0455; Paratypes, Fig. 7-10, sample, A-4, IGUT-KS3347; Fig. 7-11, sample, A-4, IGUT-KS3346; Fig. 7-12, sample, A-4, IGUT-KS3316; Fig. 7-13, sample, A-4, IGUT-KS0432.

Entactinosphaera sp.

Figures 7-4, 5.

Remarks: Several poorly preserved specimens were obtained. This unnamed species is quite similar to Entactinosphaera cimelia Nazarov and Ormiston in general shell shape. However, it differs from the latter in having wider major spines. Although this unidentified species somewhat resembles Entactinosphaera pseudocimelia, n. sp., it is distinguishable from the latter in its major spines having a triangular cross section. Specific designation is rendered until more well-preserved specimens are accumulated.

Measurements (in μm): Diameter of outer shell, 110–140; diameter of inner shell, 30–38; length of major spines, 170–220, based on five specimens.

Types: Illustrated specimens, Fig. 7-4, sample, A-7, IGUT-KS0421; Fig. 7-5, sample, A-4, IGUT-KS0753.

Tribe Triaenospheriniini Gourmelon, 1987
Type genus Triaenosphera Deflandre, 1973
Genus *Triaenosphaera* Deflandre, 1973 emend.
Gourmelon, 1987

*Type species:* *Triaenosphaera sicarius* Deflandre, 1973, Lower Carboniferous, Montagne Noire, France.

*Remarks:* The genus *Triaenosphaera* was originally introduced by Deflandre (1973) from the Lower Carboniferous of France. Subsequently, Holdsworth *et al.* (1978) examined specimens of *Triaenosphaera sicarius* Deflandre from an Upper Devonian chert of the Ford Lake Shale of Alaska. They distinguished two morphotypes: *Triaenosphaera sicarius* Deflandre (s.s.) which has four major spines and *T. sicarius* (s.l.) having fewer than three major spines. Very recently, Gourmelon (1987) documented many Tournaisian Radiolaria from Montagne Noire in France. He erected up a new Tribe *Triaenosphaerini* in the Family Entactiniidae. The genus *Triaenosphaera* is characterized by a single spherical shell with four tetrahedrally arranged spines. The four internal spicules have also a tetrahedral disposition.

*Triaenosphaera minutus* Sashida and Tonishi, n. sp.

*Figures* 8-1–6.

*Diagnosis:* *Triaenosphaera* with small spherical shell and four radially arranged three-bladed major spines.

*Description:* Small spherical shell with four major spines. Cortical shell comprises small pore frames with poorly developed nodes at their vertices. Hexagonal pore frames usually dominating. Thirty to 35 pores present on outer surface of hemisphere. Four major spines having a tetrahedral disposition and comprise 3 narrow longitudinal ridges alternating with 3 narrow longitudinal grooves. Grooves and ridges almost equal in width. Length of 4 major spines usually equal and four-fifths of diameter of shell and their distal end acute. Three-bladed thin internal tetrahedral spicules continuous with major spines at the inner surface of shell.

*Remarks:* *Triaenosphaera minutus*, n. sp. is somewhat similar in general shell feature to *T. sicarius* Deflandre described by Gourmelon (1987). However, the former species has larger pores, fewer numbers of pores and shorter major spines than those of the latter.

*Measurements* (in μm): Diameter of shell, 80–96; length of major spines, 60–75; diameter of pores, 7–11; number of pores on hemisphere; 28–31, based on 15 specimens.

*Etymology:* Latin *minutus* meaning small.

*Types:* Holotype, Fig. 8-1, sample, A-4, IGUT-KS3489: Paratypes, Fig. 8-2, sample, A-4, IGUT-KS3488; Fig. 8-3, sample, A-7, IGUT-KS3478; Fig. 8-4, sample, A-4, IGUT-KS3490; Fig. 8-5, sample, A-4, IGUT-KS0437; Fig. 8-6, sample, A-4, IGUT-KS3497.

Subfamily Astroentactininae Nazarov and Ormiston, 1985

Tribus Somphoentactini Nazur and Mostler, 1981

Genus *Copicyntra* Nazarov and Ormiston, 1985

*Type species:* *Copicyntra acilaxa* Nazarov and Ormiston, 1985, Upper Carboniferous, southern Ural, U.S.S.R.

*Copicyntra akikawaensis* Sashida and Tonishi, n. sp.

*Figures* 7-14–17.

*Diagnosis:* *Copicyntra* with 5 to 6 concentric spheres and long conical spines.

*Description:* Spherical outer shell with numerous long conical spines. Number of concentric sphere between outer shell and inner most porous sphere being usually 4 to 5. Inner sphere small with many rounded pores. Radial cross-beams arising from inner sphere and having a three-bladed form. External spines connect with radial cross-beam at base of outer shell. External spines long and rod-like, acuminata in distal part. Length of external spine exceeds a half the diameter of outer shell. Three-bladed or thin rod-like pillars also combine superimposed
concentric spheres. External spines numbering from 17 to 20 on hemisphere. Outer spongy shell represented by disorganized intervention of thin skeletal fibers forming small cells.

**Remarks:** *Copicyntra akikawaensis*, n. sp., differs from the previously reported species of *Copicyntra* in having fewer number of concentric spheres and rod-like external spines. This new species somewhat resembles *Copicyntra cuspidata* Nazarov and Ormiston reported from the Permian Artinskian Stage, southern Ural in general shell feature. However, the latter is distinguished from the former by having three-bladed external spines.

**Measurements** (in μm): Shell diameter, 150–200; diameter of inner sphere, 36–45; average diameter of intercalated shells proceeding inward by from outer spongy layer, 160, 133, 113, 110 and 80; spine length, 40–93, based on 15 specimens.

**Etymology:** Species name *akikawaensis* is derived from Akikawa-river.

**Types:** Holotype, Fig. 7-14, sample, A-4, IGUT-KS3345: Paratypes; Fig. 7-15, sample, A-4, IGUT-KS0467; Fig. 7-16, sample, A-4, IGUT-KS3332; Fig. 7-17, sample, A-7, IGUT-KS3458.

**Genus** *Uberinterna* Sashida and Tonishi, n. genus.

**Type species:** *Uberinterna virgispinosum* Sashida and Tonishi, n. sp.

**Diagnosis:** Astroentactiniinae with thick spongy outer shell and porous inner shell. Inner shell comprises 4 to 5, rarely more, thin concentric spheres. Internal spheres connected with each other by numerous thin rod-like beams. Internal spheres also being crossed by radial cross-beams joining with base of major spines.

**Remarks:** This new genus is distinguished from other genera of Astroentactiniinae, such as *Somphoentactinia* Nazarov and *Spongontactinella* Nazarov by having concentric internal spheres. On the other hand, the genera *Copicyntra* Nazarov and Ormiston and *Copicyntroides* Nazarov and Ormiston have superimposed thin concentric spheres. The new genus *Uberinterna* is additionally characterized by three-bladed cross-beams. These features of cross-beams are not recognized in the previously reported genera of Astroentactiniinae.

**Etymology:** Latin *uber* meaning abundant and *interna*, inner part; gender, neuter.

*Uberinterna virgispinosum* Sashida and Tonishi, n. sp.

Figures 2; 8-7-12.

**Diagnosis:** *Uberinterna* with thick spongy outer shell and 4 to 5 thin concentric spherical shells. Several major spines rod-like and rather short.

**Description:** Spherical outer shell, thick and spongy with several rod-like spines. Outer surface of outer shell uneven lacking any small spines, whereas inner surface usually smooth (Figs. 8–9, 12). However, some specimens have spongy fabric and intervening fibers, which are in contact with outer surface of inner shell. Thickness of outer shell wall exceeds one-fifth the one of a half diameter of outer shell. Major spines rather short and conical or rod-like. They gradually taper off to a distal end. Sometimes, wide and rather deep grooves develop from base to one-third the length of major spines. Six major spines counted in well-preserved specimens. Inner shell comprises 4 to 5 thin concentric spheres.
Innermost sphere has a thin wall penetrated by rounded oval pores. Several thin internal spicules observed in innermost sphere, but their disposition not clear in presently available specimens. Three to 4 concentric spheres small with rounded pores. Each concentric sphere being connected by thin rod-like beams. Rarely very small secondary spines or nodes developing on outer surface of outermost sphere of inner shell. Diameter of inner shell less than a half diameter of outer shell. Six radial cross-beams arising from inner shell have a three-bladed form. They become gradually wide toward inner surface of outer shell and contact with external spines.

Remarks: This new species somewhat resembles Thecentactinia riedeli (Foreman) in general shell shape. However, the former is easily distinguished from the latter by the above described shell characters.

Measurements (in \( \mu \text{m} \)): Diameter of outer shell, 250–300; thickness of spongy layer of outer shell, 25–30; length of external spines, 65–100; diameter of outermost sphere of inner shell, 85–93; diameter of innermost sphere, 25–33; average diameter of intercalated spheres proceeding inwardly from the outermost sphere of inner shell, 80, 47 and 33, based on 11 specimens.

Etymology: Latin virga, twig or branch and spinosus, thorny.

Types: Holotype, Fig. 8-7, sample, A-4, IGUT-KS3496; Paratypes, Fig. 8-8, sample, A-4, IGUT-KS3453; Fig. 8-9, 12, sample, A-4, IGUT-KS3492; Fig. 8-10, sample, A-7, IGUT-KS3001; Fig. 8-11, sample, A-4, IGUT-KS3487.

Superfamily Latentifistulideo Nazarov and Ormiston, 1983
Family Tormentidae Nazarov and Ormiston, 1983
Genus Tetratormentum Nazarov and Ormiston, 1985

Type species: Tetratormentum narthecium Nazarov and Ormiston, Upper Carboniferous, Gzhelian Stage, southern Ural, U.S.S.R.

*Figure 3.* Schematic view of *Tetratormentum acutum* Sashida and Tonishi, n. sp. presenting its nomenclature.

*Tetratormentum acutum* Sashida and Tonishi, n. sp.

Figures 3; 10-7, 10

Diagnosis: *Tetratormentum* with distorted pyramidal shell. One small spherical internal sphere with very thin four-rayed internal framework enclosed in rather thick spongy shell (Fig. 3).

Description: Outer spongy pyramidal shell thick, rather large and distorted toward dorsal side. Spongy fabric of outer shell very fine. Distal end of spongy shell abruptly tapers toward terminal spine. Internal framework represented by a nonporous sphere somewhat shifted toward base. Three very thin rays arising from sphere at an angle of about 120 degrees from one another and fourth one bended toward dorsal side at an angle of about 30 degrees from a vertex (Fig. 10-10). Diameter of internal sphere less than one-fourth the length of internal ray. Internal ray gradually thicken toward distal part and connected with external spine at base of spongy shell. Terminal spines fairly thick and conical. Some forms possessing 2 or 3 short and shallow openings near base. Length of well-preserved terminal spine about one-third of internal ray.

Remarks: *Tetratormentum acutum*, n. sp. is characterized by its distorted spongy shell with fairly massive and conical terminal spines. This new species somewhat resembles *Tetrator-
mentum nartheicum Nazarow and Ormiston, the
type species of the genus Tetratormentum. However,
the latter species has a more rounded
pyramidal shell and thinner terminal spines than the
former.

Measurements (in μm): Height of pyramid
except terminal spine, 235–255; basal width,
280–330; diameter of internal sphere, 35–45;
diameter of internal rays, 4–8; length of terminal
spines, 7–10, based on 9 specimens.

Etymology: Latin acutus meaning acute or
sharpened.

Types: Holotype: Fig. 10-10, sample, A-4,
IGUT-KS0948: Paratype, Fig. 10-7, sample, A-4,
IGUT-KS0945.

Tetratormentum globiforme Sashida and
Tonishi, n. sp.

Figures 4; 10-11,12.

Diagnosis: Tetratormentum with globular
coarse spongy shell and porous internal sphere.
External terminal spines thick and long conical
arising from internal rays (Fig. 4).

Description: Globular shell thick with a
porous internal sphere and conical massive exter-
nal spines which arise from internal rays. Spongy
shell comprising fairly coarse spongy fabric,
sometimes creating an impression of it being
divided into several layers. Inner surface of shell
usually smooth, but sometimes coarse spongy
fabric of shell combined with internal sphere.
Porous internal sphere spherical to depressed
spherical with circular to oval pores. Diameter of
internal sphere less than one-third of the outer shell
diameter. Internal rays arising from internal
sphere at an angle of 120 degrees from one
another and the fourth ones arranged perpendi-
cularly to other three. Usually, internal rays
rod-like, but sometimes three-bladed. Thick
terminal spines also rod-like and gradually taper
off distally.

Remarks: In some specimens, there observed
are one or two incomplete spheres made of a
coarse spongy fabric in which the internal sphere
is closed. The present authors tentatively in-
cluded these forms to this species.

Measurements (in μm): Diameter of shell,
300–350; diameter of internal sphere, 70–90;
maximum diameter of terminal spines, 35–50;
length of the terminal spines 120–180, based on
8 specimens.

Etymology: Latin globus meaning ball and
formis, shaped.

Types: Holotype, Fig. 10-11, sample, A-4,
IGUT-KS0923: Paratype, Fig. 10-12, sample,
A-4, IGUT-KS0946.

Genus Octatormentum Nazarow and
Ormiston, 1985

Type species: Octatormentum cornelli
Nazarow and Ormiston, 1985: Lower Permian,
Leonardian Stage, Bone Spring Limestone, West
Texas, U.S.A.

Octatormentum ? floriferum Sashida and
Tonishi, n. sp.

Figures 5; 10-1–4.

Diagnosis: Tormentidae with spongy shell and
internal sphere. Spongy shell of double pyrami-
dal form with six major spines, four emerging at
apices of each pyramid. External spines con-
tinuous with 6 internal rays (Fig. 5).

Description: Rather large shell of double
pyramidal form whose distal half of apices protruded in a dome-like fashion. Terminal spines emerging at 4 equatorial corners and 2 apices. Diameter of dome-like protrusion less than height of shell. Shell thick and spongy. Inner surface of shell smooth, but rarely fine-spongy fabrics sticking out. Internal sphere small, nonporous and covered with 6 emerging rays. Junction of these rays not observable within the sphere. Diameter of internal sphere less than one-fifth that of outer shell. Internal sphere situated at the center of shell. Internal rays thin, rod-like and continuous to base of major external spines. External spines rod-like, finely threelbladed at the basal part, and gradually tapering off distally. Six external spines usually equal length. Maximum length of external spines nearly equal with diameter of dome-like protrusion.

Remarks: According to Nazarov andOrmiston (1985), the genus Octatormentum is characterized diagnostically by having 3 shells and 6 major spines. Although the present authors' specimens have only 2 shells, other shell features are quite identical with the criteria given by Nazarov and Ormiston (1985). Therefore, the present authors tentatively assign this new species to the genus Octatormentum. Octatormentum ? floriferum, n. sp. is easily distinguished from other previously described species of Octatormentum by the above-mentioned shell characters.

Measurements (in μm): Maximum height of shell excluding terminal spine, 290–320; maximum diameter of shell, 300–350; diameter of internal sphere, 30–45; length of external terminal spines, 45–55, based on 8 specimens.

Etymology: Latin florifer meaning flower bearing.

Types: Holotype: Fig. 10-2, sample, A-4,
Type species: *Triplanospongus musashiensis* Sashida and Tonishi, n. sp.

**Diagnosis:** Shell comprising three double-ridged arms with triangular spongy fabrics and conical terminal spines. Arms radiating from the center of shell at an angle of 120 degrees. Small triradiate plate present at the center of shell. One or two narrow ridges, I-shaped in cross section, being arranged parallel to arm at nearly mid-part of spongy shell. This ridge coming in contact with arm at distal end of shell or amalgamated with surrounding spongy fabrics.

**Remarks:** *Triplanospongus*, n. g. is quite similar to the genus *Foremanhelena* De Wever and Caradroit of the Family Tormentidae in outer shell shape. However, the shell structure of the former genus is completely different from the latter. Namely, this new genus does not have the tube-like triradiate arms and spherical central shell. This character is not recognized in other genera of the Superfamily Latentifistulidae. Therefore, the present authors place this new genus in the Spumellaria incertae sedis. The genus *Tetraditryma* Baumgartner of the Mesozoic Family Hagiastridae possess basically H-shaped external beams. Nevertheless, the ray of the genus *Tetraditryma* is composed of a medullary shell, cortical bar, cortical walls and pores (Baumgartner, 1980, fig. 4).

**Etymology:** Latin *tri* meaning three, *plano* to make flat, and *pongos* sponge; gender masculine.

*Triplanospongus musashiensis* Sashida and Tonishi, n. sp.

**Figures 6; 9-7-12.**


*Angulolabrachia* ? sp., Yoshida and Murata, 1985, pl. 2, fig. 18.
**Diagnosis:** Triangular platy shell comprising three arms and covered by spongy fabrics. Each arm of triangular spongy shell tipped by a rather long, conical, terminal spine.

**Description:** Triangular platy shell comprising three double-ridged arms and covered by spongy fabrics. Arms diverging at an angle of 120 degrees from center. Triradiate and rather massive small plate located at center of shell. One of two ridges fabricating double-ridged arm usually disappearing at the distal end. In rare instances, both ridges becoming amalgamated with each other to form single-ridged arm. At distal part of shell, arm merging with spongy fabric. One or two massive I-shaped ridge running parallel to arm in the middle part of spongy shell and the ridge often coming to merge with one of ridges on the arm. Spongy fabrics serving to connect arm and I-shaped ridge in such manner as shown in Fig. 6. Pores of spongy fabric rather large and circular to oval. Spongy fabrics usually covering I-shaped ridges at the distal part of shell. A rather long conical spine terminating from one of ridges on the arm at distal end. Three narrow and shallow grooves present near the base of spines. Length of spines about one-third the distance from center to distal end of arm. Three side of triangular spongy shell slightly indented near mid-point as marked a or a’ in Fig. 6. Thickness of double-ridged arm being nearly one-third of length of arm.

**Remarks:** As discussed earlier, *Triplanospongus musashiensis*, n. sp. resembles *Foremanhelea triangula* De Wever and Caridoirit. Furthermore, this new species is similar to *Tormentum circumfusum* Nazarov and Ormiston described from the Lower Permian of southern Ural in its outer shell shape. However, this new species is easily distinguished from these two species by lacking the important character of stauraxon polycystines.

**Measurements** (in μm): Length of rays from center to distal end of shell, 170–230; height of triangle, 340–400; thickness of shell, 65–72; length of terminal spines 45–90, based on 25 specimens.

**Etymology:** Species name *musashiensis* comes from the ancient geographical name, Musashi, for the western part of Tokyo Prefecture.

**Types:** Holotype, Fig. 9-7, sample, A-4, IGUT-KS0371; Paratype, Fig. 9-8, sample, A-4, IGUT-KS0372; Figs. 9-9,12, sample, A-7, IGUT-KS0766; Fig. 9-10, sample, A-4, IGUT-KS0370; Fig. 9-11, sample, A-4, IGUT-KS0826.

**References**


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東京都西部, 五日市から産する上部ペルム系放置生物の追加報告: 東京都五日市町柏原付近に分布する海溝層に含まれるチャート岩塊からは保存良好な上部ペルム系放置生物が多数に産する。この放置生物のうち, Entactinidae, Palaeoactinomidae, Palaeoscenidiidae, Phacodiscidae科及びLatentifistulidea超科の一属についてはすでに筆者らにより記載・報告されている。本研究ではEntactinidae, Torgentidae, Albaillellidae科及び所属不明のSpurnellariaについて新たに検討を行い, Uberinterna, Triplanospongiosの2新属を含む, 10種の新種を識別し、記載した。本研究ではさらに五日市産上部ペルム系放置生物群と西南日本超丹波帯の上部ペルム系放置生物群及び北米West TexasのDelaware Basinの放置生物群との比較も行った。指田勝男・遠西敬二